For engineers who design and manage the power and plant services

Power

MARCH 1960

ONE DOLLAR

A McGRAW-HILL PUBLICATION

Conditioned Air for Industry

a 16-page special report... 53

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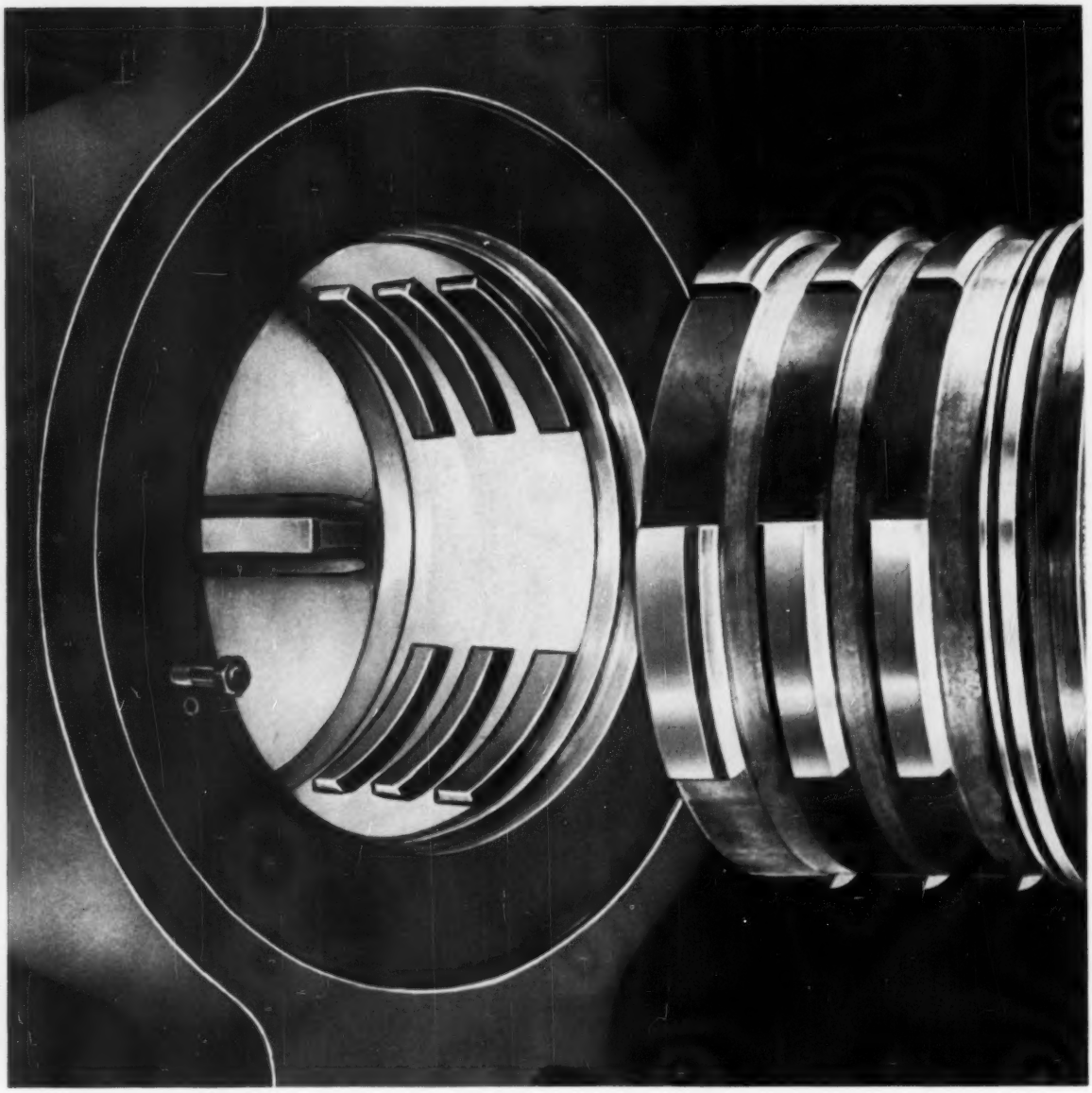

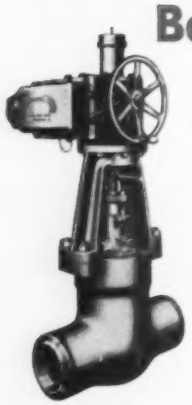

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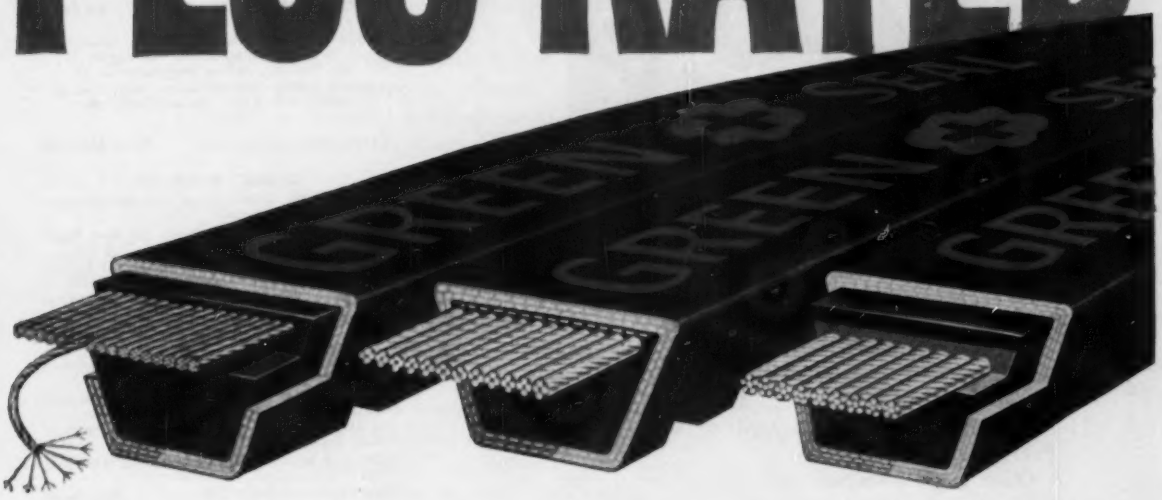

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The full story on why and how all V-Belts with the Green Seal have been "PLUS-RATED" goes back to their introduction in May 1957, and is too long to detail here. See your Goodyear Dealer for all the performance-proved facts and figures. Or write Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

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speaking of **Power**

VOPAT AND SKROTZKI talk over their latest book

As you might expect, most POWER editors turn to book writing as an avocation. Top man on the staff, numberwise, is Associate Editor Ben Skrotzki. His latest, *Power Station Engineering and Economy*, was coauthored with Bill Vopat, Professor and Head of Mechanical Engineering at Cooper Union School of Engineering. Current book is a second edition (with title changed) of their *Applied Energy Conversion.*

Other books from Skrotzki's pen are *Steam and Gas Turbines, Electric Transmission and Distribution, Electric System Operation, Electric Generation —Steam Stations, Electric Generation — Hydro, Diesel and Gas-Turbine Stations*, and *Nuclear Engineering.* Ben's next, expected in about two years, will be based on the current "Thermo refresher" series now in its 36th installment. He then hopes to write an "Engineering science refresher" series for POWER which will probably appear later in book form.

What's Skrotzki's "best seller"? The Engineers Council for Professional Development distributed some 270,000 copies of Ben's 32-p booklet, "Engineering—a Creative Profession," a guide for high-school students and parents.

Lou Lowley

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Print order this issue: 49,670

POWER (with which are consolidated *Science and Industry, The Engineer Review, The Engineer, The Stationary Engineer* and *Operating Engineer*) is published monthly by McGraw-Hill Publishing Company, Inc, James H McGraw (1860-1948), Founder. PUBLICATION OFFICE: McGRAW-HILL BUILDING, 330 W 42nd St, New York 36, N. Y. See box, right, for directions regarding subscriptions or change of address.
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United States subscription rate for individuals in the field of the publication $5.00 per year, single copies $1.00, unless otherwise indicated. Canada; $7.00 for one year. Foreign; $15.00 for one year. Second-class

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Power articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. Power publishes its own annual index, obtainable on request to the Editor. Notice of availability appears in Power.

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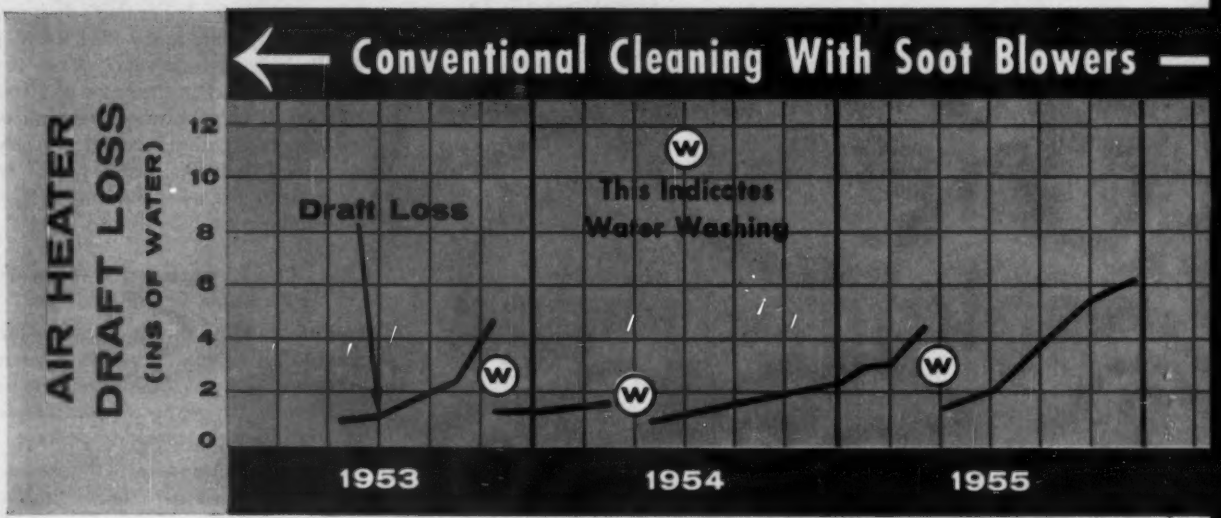

Here is an example of how Diamond Shot Cleaning solves certain cleaning problems previously impossible of solution.

The chart shows increase in draft loss across a tubular air heater resulting from ineffective soot blower cleaning. Mounting draft loss caused decrease in fan capacity and reduction in load. During the first four years of operation it was necessary to water wash this air heater six times (at "W"). Each washing required a three day outage of the boiler.

Diamond Shot Cleaning was installed in September 1957. Since then draft loss has been minimum and uniform. Water washing with consequent boiler outage has been eliminated entirely.

This first installation was so successful that a second air heater was equipped with shot cleaning in 1958.

Diamond Shot Cleaning uses falling shot to clean horizontal tube surfaces such as superheaters, reheaters and economizers, as well as tubular air heaters. The shot is cascaded over the horizontal tubes or through vertical air heater tubes by distributors and scours the surfaces as it falls. Deposits are removed in small particles most of which are carried away by the gas stream. Heavier particles fall into the hopper and recirculate with the shot until broken fine enough to be picked up by the gases. Cleaning is thorough even with difficult fouling such as is found in black liquor fired boilers. Areas which tend to foul rapidly can be kept completely clean by increasing the automatic shot cycle (it may be continuous if necessary) without disturbing boiler operation.

In line with our half century policy of providing the best in boiler cleaning, Diamond has conducted extensive research on shot cleaning over a period of years. More than 30 installations are now in successful operation in United States . . . some of them since 1954. To supplement this program, Diamond has acquired the U. S. rights to the Broman-Ekstrom system, of which there are more than 800 successful installations in Europe.

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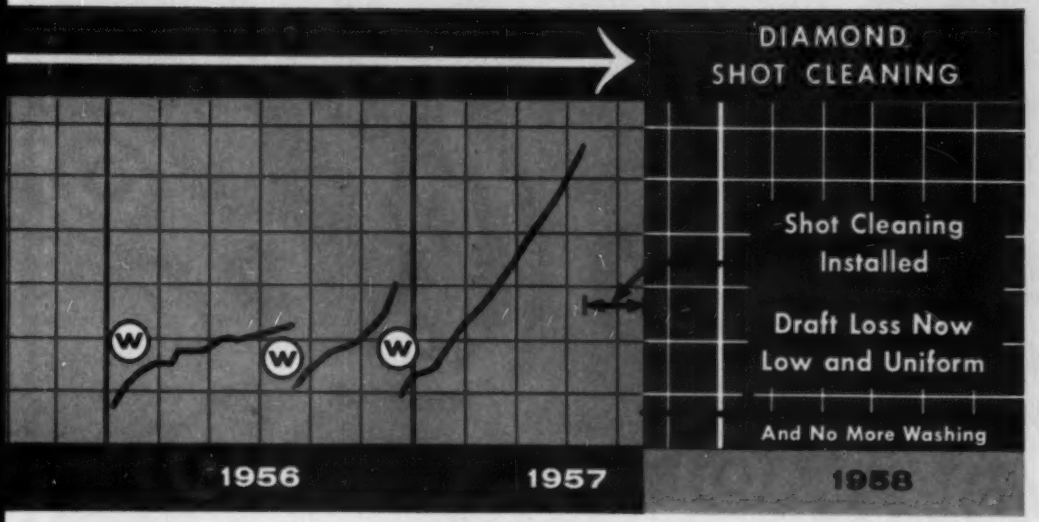
Shot Cleaning

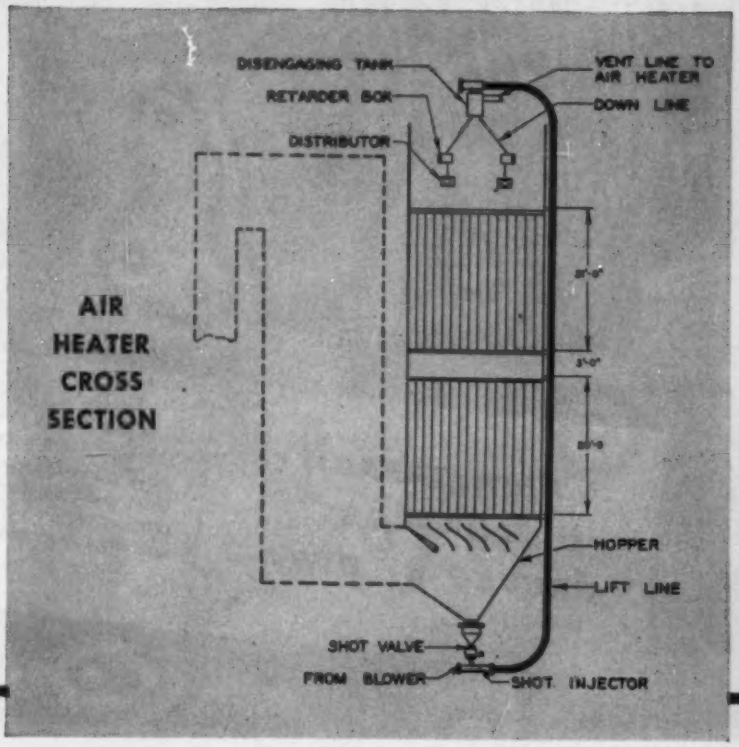
HEATERS CLEAN

be CLEANED BEFORE



WRITE FOR
BULLETIN 2145 ON
DIAMOND SHOT CLEANING

It has complete information, including data on shot lifting methods. For better boiler cleaning at lower cost, the answer always is Diamond.



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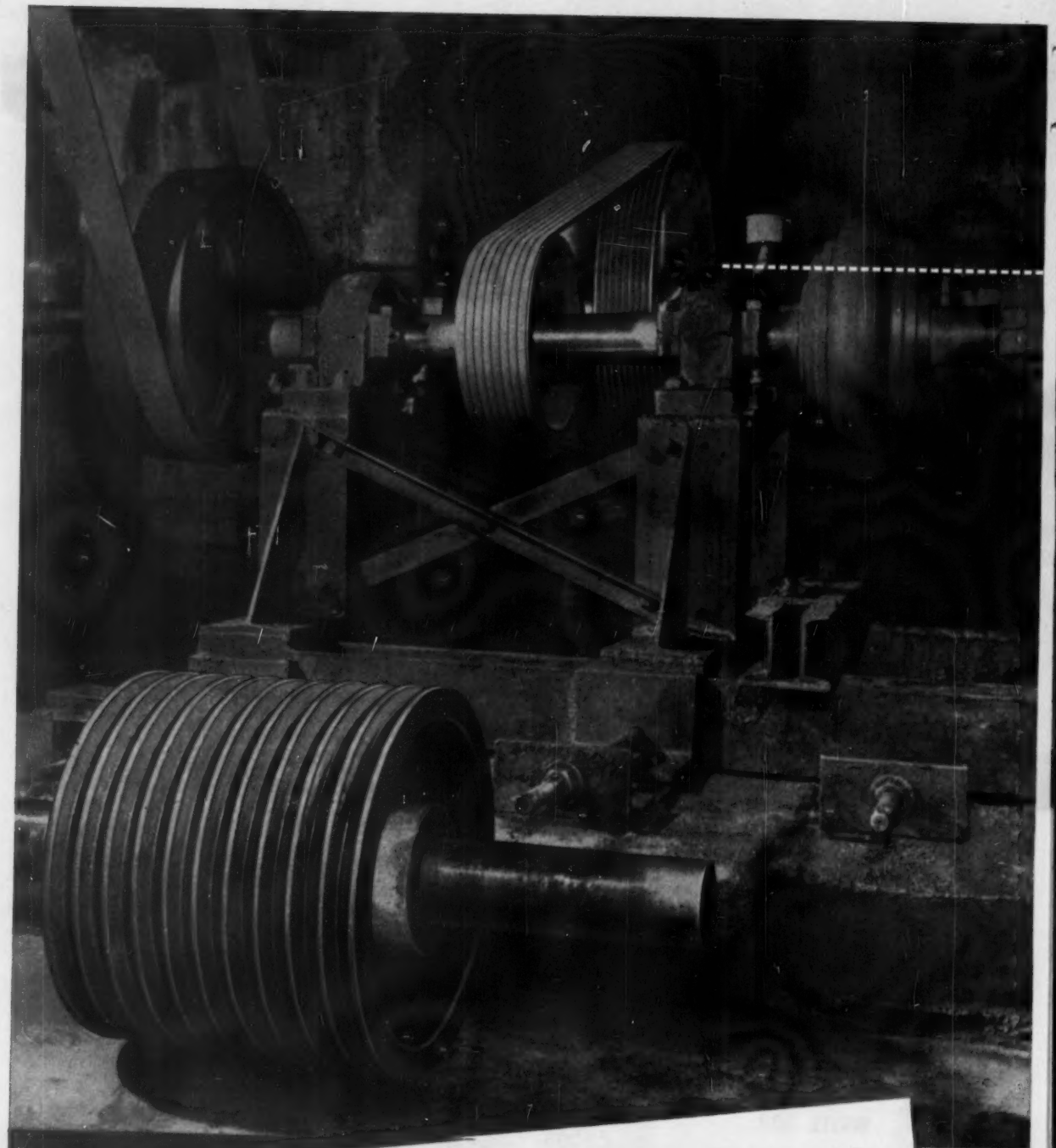
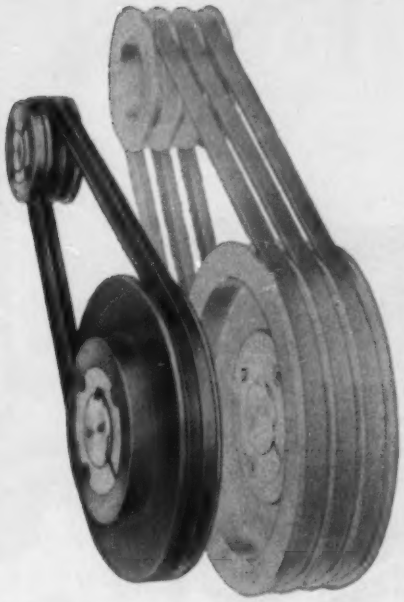


HIGH CAPACITY LOW COST PROVED BY DYNA-V

Here is a Dyna-V Drive on a paper mill line shaft. The 8-groove, 5-V Dyna-V driver sheave replaces the 10-groove D-section sheave shown in foreground. Dyna-V delivers the same power — in a far more compact drive — with a $477 difference in price — and big future savings in belt replacement cost!

Dyna V

THE NEW MONEY-SAVING IDEA IN V-BELT DRIVES!



Dyna-V compared with big-groove drive for same hp. Dyna-V is capable of handling 3 times as much hp in the same space! Dyna-V Drives are available for capacities from 1 to 1500 hp.

The day of big-groove sheaves and belts is passing. The new idea of compact V-belt drives—Dyna-V—introduced by Dodge just a few short months ago, is taking the country by storm. Thousands of Dyna-V Drives are at work in industry everywhere, carrying their loads easily, dependably, and proving their ability to *deliver more horsepower per dollar!*

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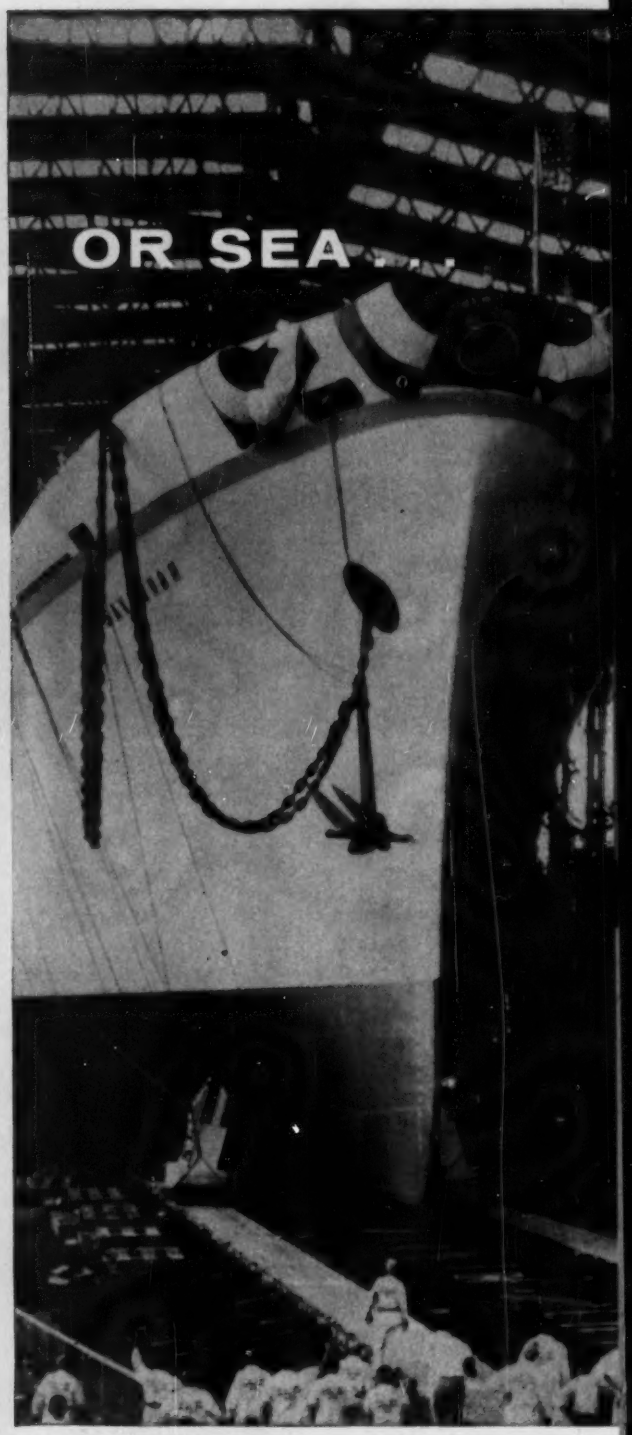

The NS Savannah, first Nuclear merchant ship, is controlled from a "Bailey Board" which includes Nuclear Instrumentation and Bailey Reactor Controls as well as Bailey Steam Plant Instruments and Controls.

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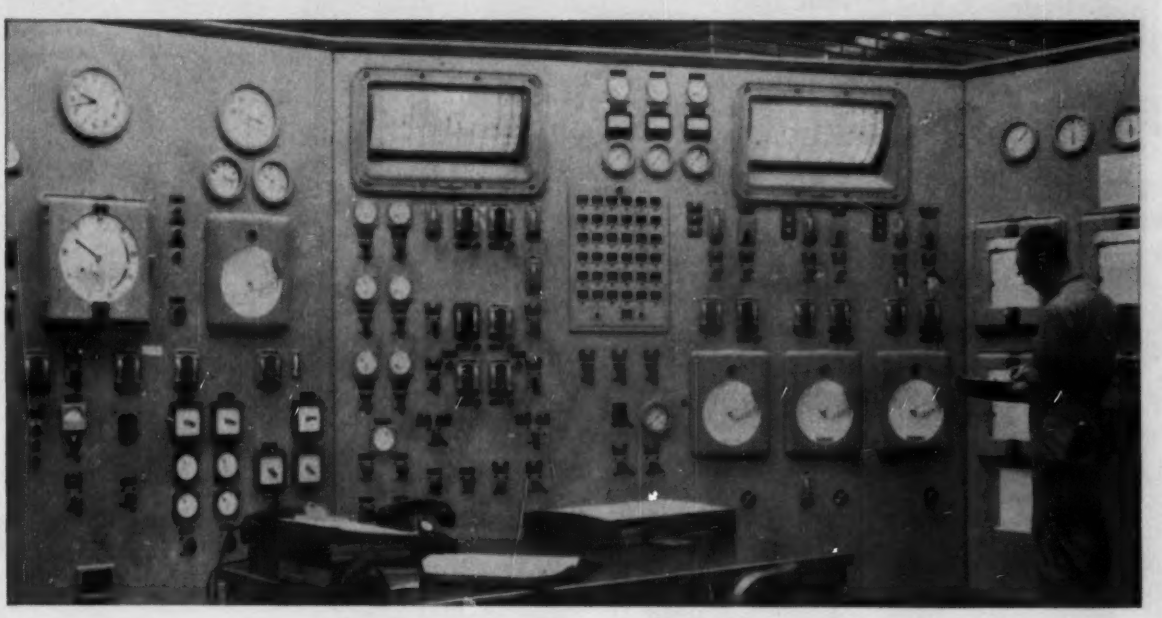

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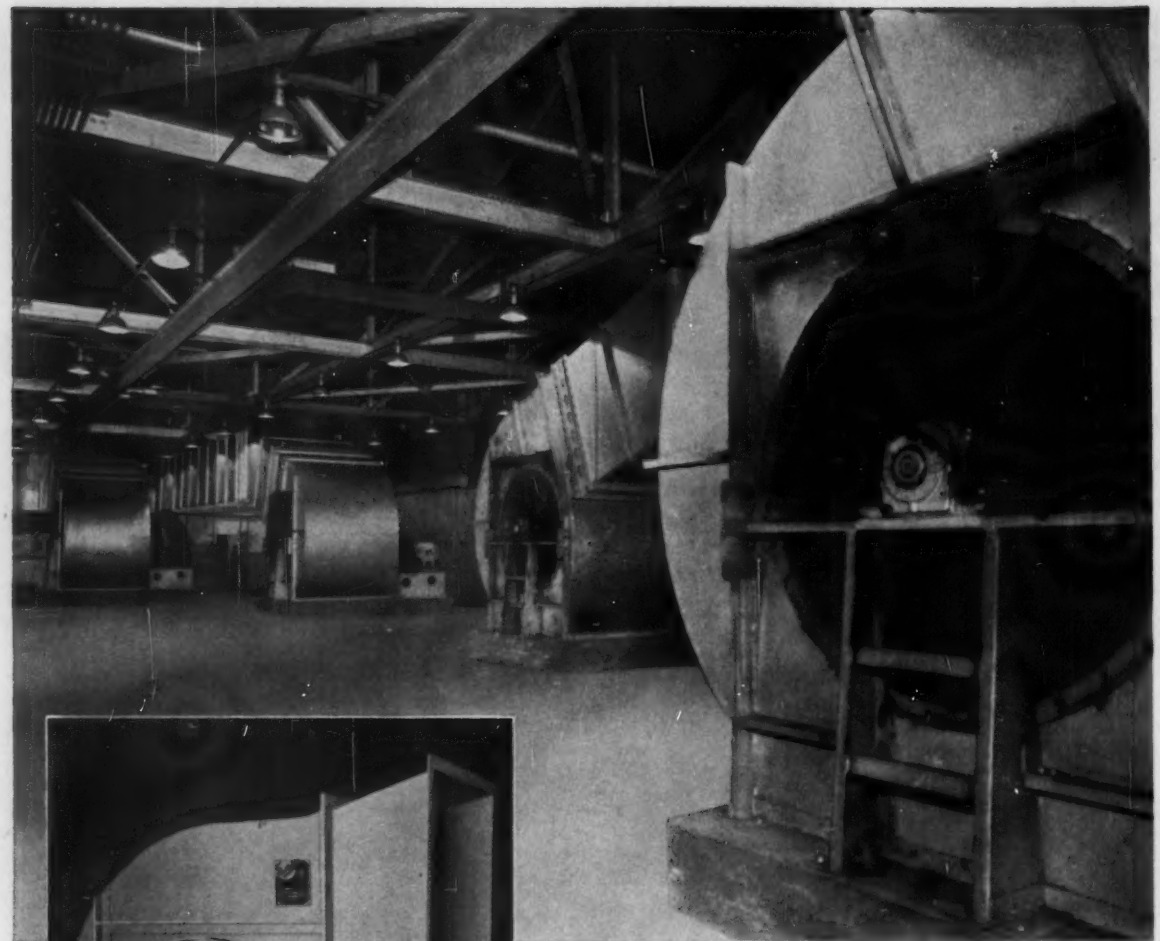

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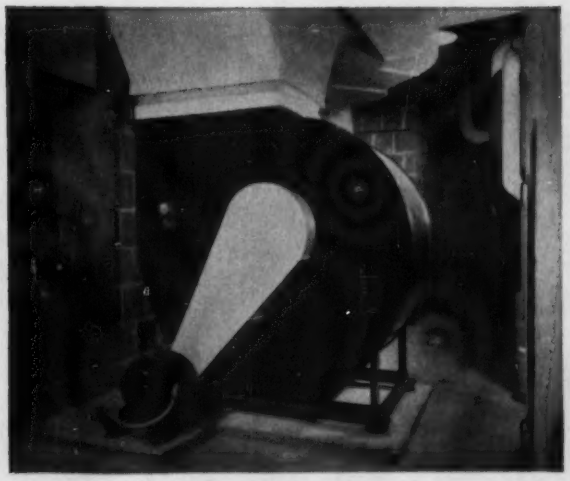
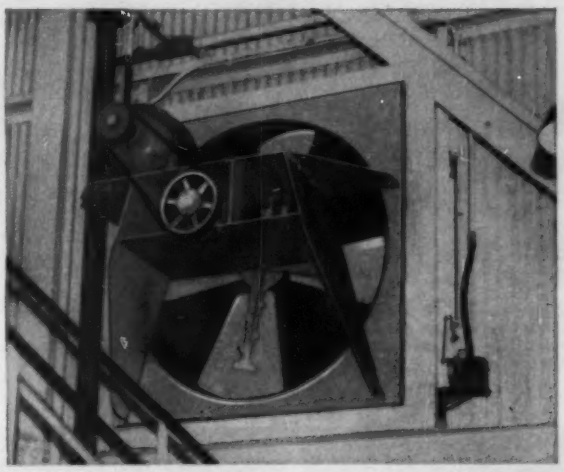


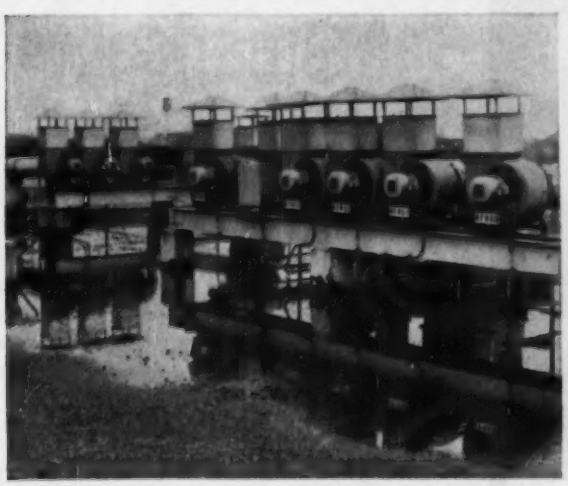
CENTRAL SYSTEM ventilation, which very often incorporates air conditioning and heating, requires the high efficiencies and capacities of large centrifugal fans. Capacities range to 500,000 cfm.

THROUGH THE ROOF is the best way to ventilate large areas where duct work is undesirable. Allows flexibility of plant layout. New models in capacities up to 250,000 cfm.

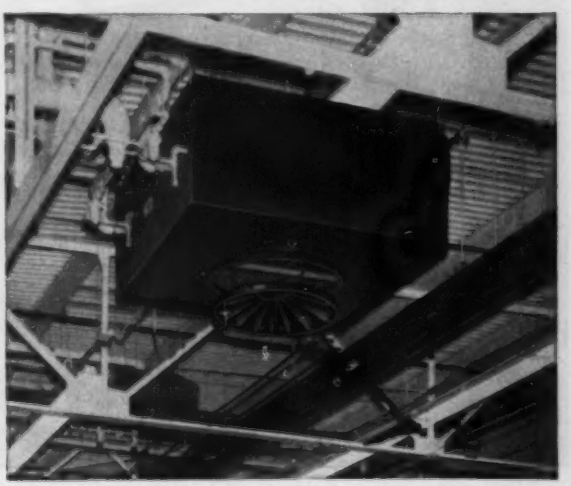
CONFINED AREA exhaust such as spray booths, hood installations, function best with efficient, powerful axial flow fans. Units easily installed in ducts.



LOWEST COST ventilation for open areas is made possible by large propeller fans. New designs offer higher efficiencies, larger capacities (250,000 cfm).

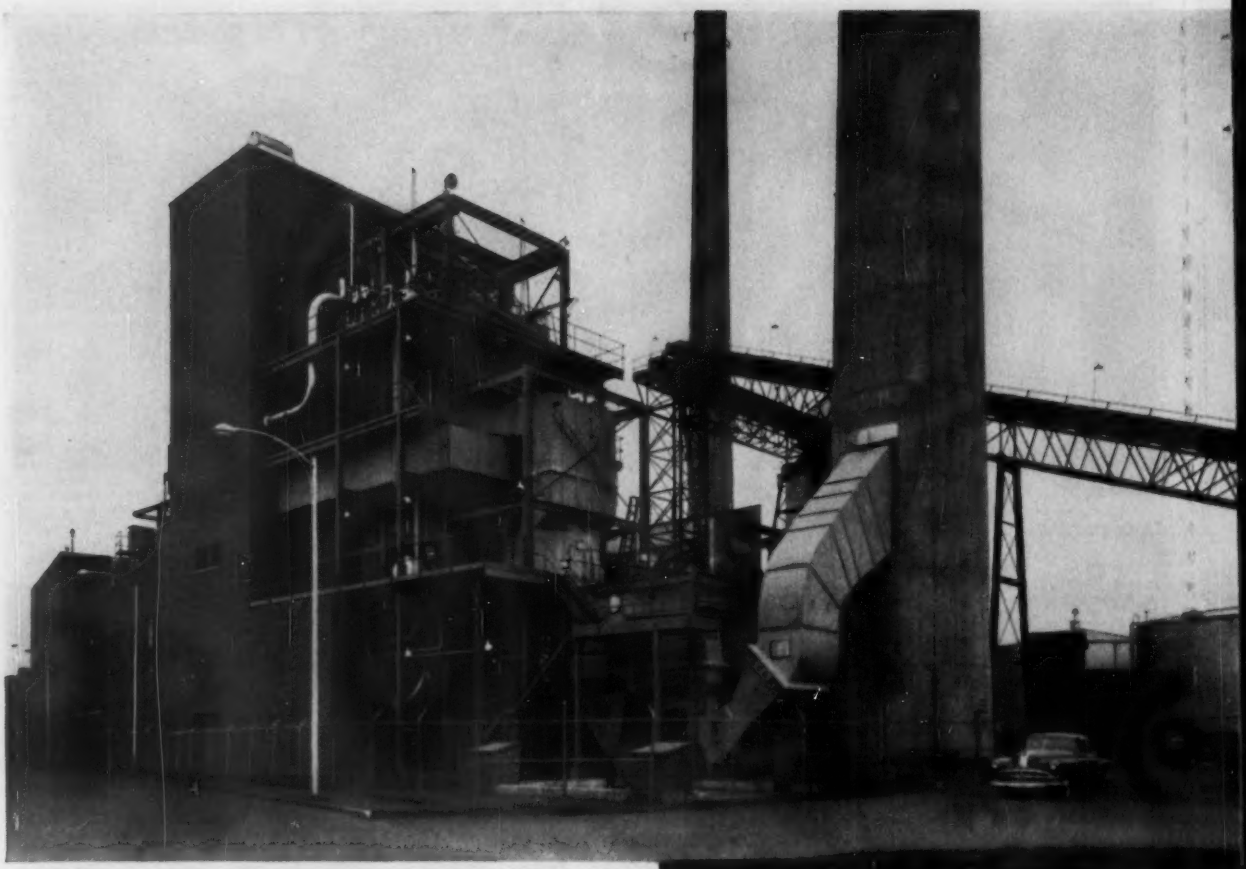


CORROSIVE FUMES can be exhausted with cast iron fans as shown. Also available are fiber glass fans, rubber and other specially coated units.

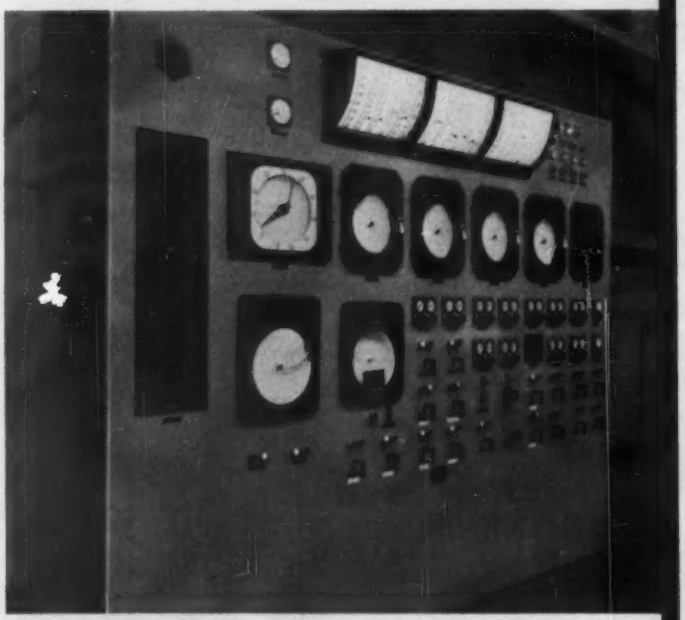


PUTTING BACK AIR exhausted is job for low cost, high capacity make-up air units. Fans, heating coils, filters, diffusers included in "package" units.

For more facts circle 209 on Reader Service card, p 109

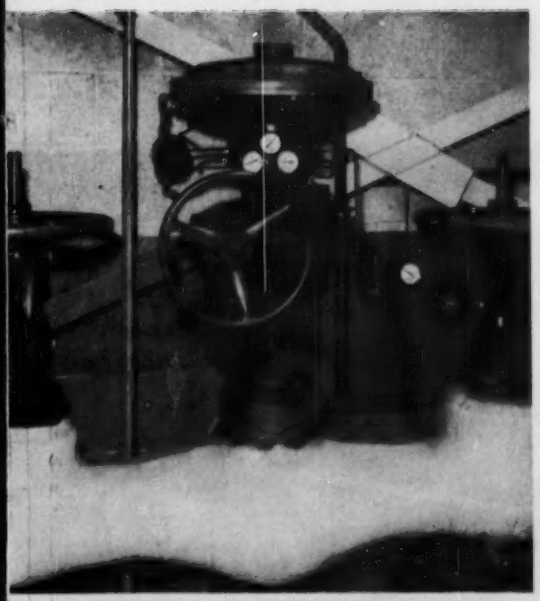


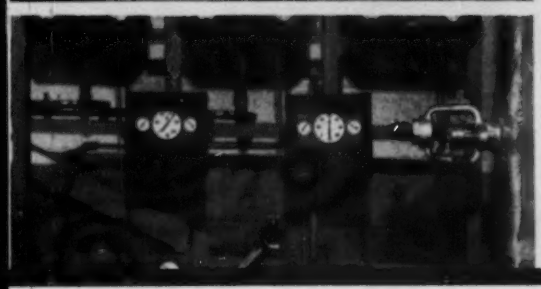
Except for the firing aisle and control room, Boiler Unit 7 is outdoors and subject to sub-zero temperatures. The unit delivers steam at 850 psig and 900°F to a 16,500-kw turbine-generator installed in the tail building (left) some 200 feet away.



Eleven miniature Copes-Vulcan stations on this operating panel provide remote control of all processes with automatic-to-manual, or manual-to-automatic selection, with "bumpless" transfer. Automatic and manual loadings can be matched perfectly without going through a seal or reset position.

Copes-Vulcan boiler control automatically balances output with demand at Taunton Plant





Diaphragm-type control valve (upper left) is used with Copes Type 3-L feedwater control. The valve features positioner, air lock, and side-mounted handwheel for emergency operation.

Designed for superior accuracy and long range dependability, Copes-Vulcan valves establish new standards of efficiency for pressure, temperature, flow, and level control.

Two versatile regulator valves are available for pressure standards from 125 through 2500 pounds. Diaphragm-type CV-D is designed for remote control service, can be direct or reverse acting, features excellent rangeability. Piston-type CV-P is designed for high-duty service, assures maximum power with precise positioning. **Write for Bulletin 1027.**

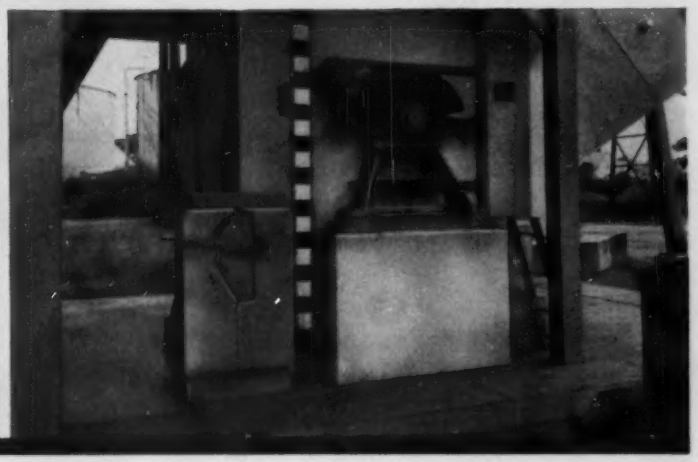
The two field mounted Copes-Vulcan indicating pressure transmitters (lower left) are used for feedwater (left) and fuel oil (right). Proportional action with pneumatic feedback is ideal for pressure-regulating service.

Copes-Vulcan transmitters feature good repeatability. Standard output pressure is 3 to 15 psi for input bands of 1 to 100%. Outputs of 6 to 30 psi and 12 to 60 psi are also available. **Write for Bulletin 1036.**

Drive unit (right) for the inlet damper of the induced-draft fan is installed at ground level outdoors. Insulation, used for protection against adverse weather, is easily removed for inspection and maintenance of the unit.

Copes-Vulcan Drive Units permit remote positioning by automatic or manual signals. They may have linear, square, or square-root characteristics, or may be field-characterized.

Five models are available. All have 90-degree angular rotation and may be manually operated by a handwheel. **Write for Bulletin 1033.**



The Municipal Lighting Plant in Taunton, Massachusetts, selected Copes-Vulcan to provide Unit 7 with precision boiler control. Featuring simplicity of circuits and dependable accurate components, the Copes-Vulcan system automatically maintains a constant main steam-header pressure under varying demands. Peak loads reach 170,000 pounds per hour. Operation remains under fully automatic control down to 40,000 pounds per hour.

Unique combustion control includes skillfully designed circuits for fuel-loading report-back and fuel cut-back. Other controls assure constant furnace pressure, the correct ratio between steam flow and air flow, and a practically constant drum water level.

Temperatures and pressures regulated. Air-heater temperature, mill pressure, and steam temperature at the superheater outlet are accurately managed.

A complete line—a complete service. In addition to boiler control, the Copes-Vulcan line includes complete systems for fully automatic soot blowing, pressure reducing, and desuperheating. All are custom engineered. All are backed by more than 50 years of design experience.

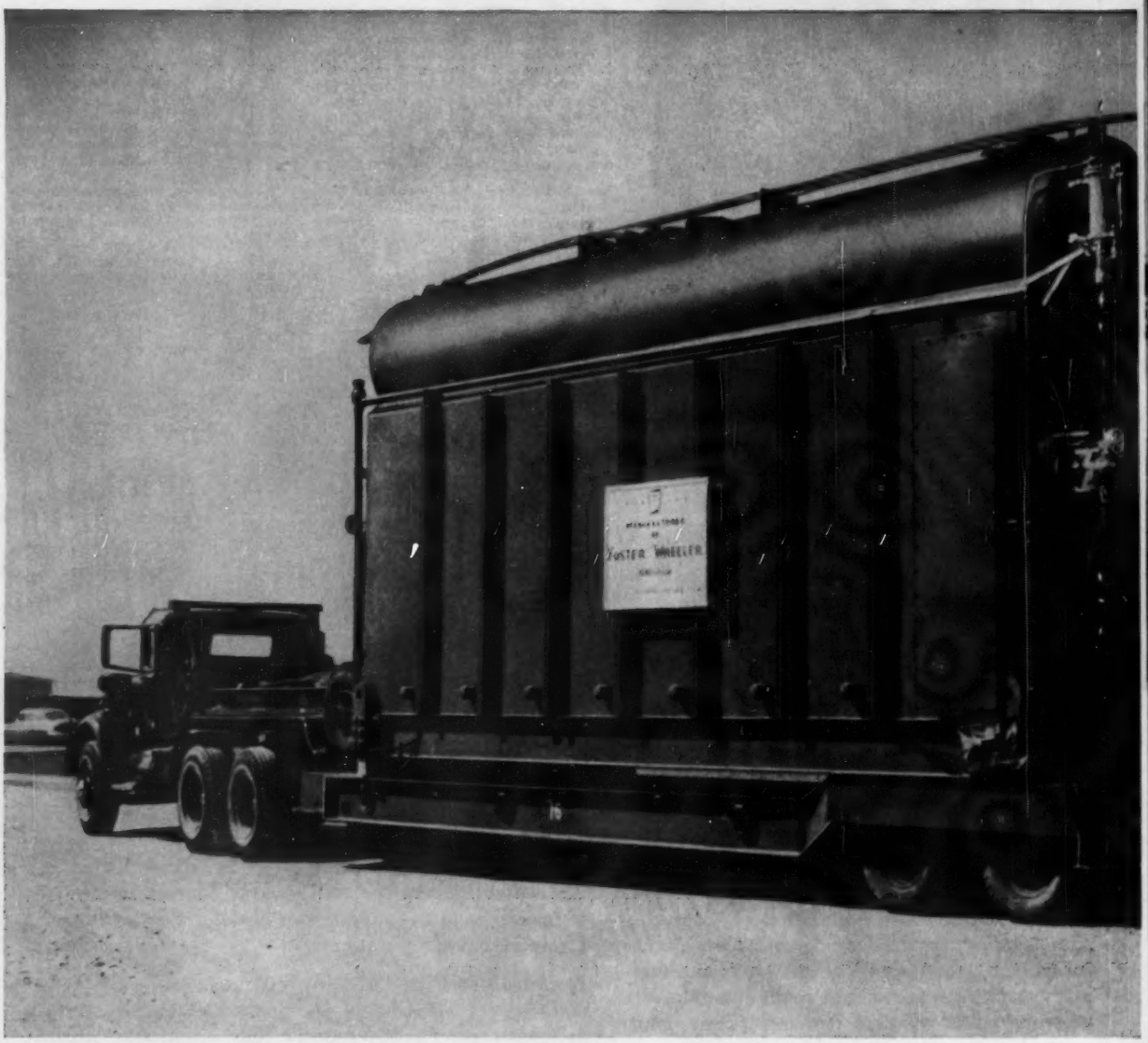
Whether your boiler be large or small, power or process, Copes-Vulcan can provide a unit or a coordinated package to meet your requirements.

For the complete story, write for Bulletin 1065. Copes-Vulcan Division, Erie 4, Pennsylvania.

Copes-Vulcan Division

BLAW-KNOX

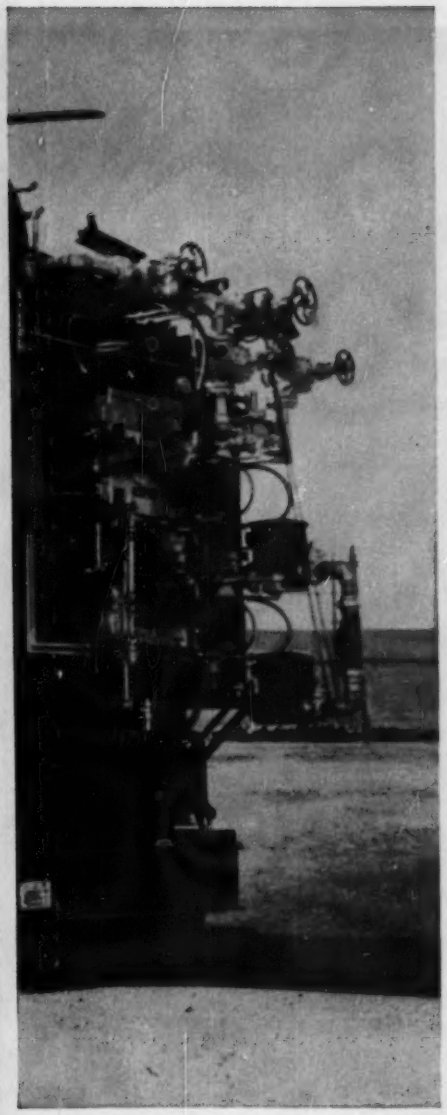
For more facts circle 210 on Reader Service card, p 109



Foster Wheeler Packaged Steam Generator on its way to a refinery, where it is now producing 50,000 lb/hr of high-purity steam for processing and heating purposes.

—PETROLEUM PROCESSING

—CHEMICAL PROCESSING



Foster Wheeler delivers the steam you need and the economy and efficiency you want, in one package

If you need 13,000 lb/hr or more of steam at pressures of 250 psi or above, one of the best ways to begin planning your steam generator installation is by contacting Foster Wheeler right now.

This is Foster Wheeler's record of experience in meeting steam requirements with packaged steam generators.

The first water tube shop-assembled packaged unit was built by Foster Wheeler in 1940, to solve an important defense problem. Today, standard Foster Wheeler Packaged Steam Generators, firing fuel oil and gas separately or in combination, are serving refineries, process and manufacturing plants, hotels, dairies . . . virtually every type of business and industry throughout the world.

Most recent Foster Wheeler development in packaged steam generators is a stoker fired model, the first available to industrial users of steam.

In short, the *heat engineering* experience that goes into Foster Wheeler Packaged Steam Generators is unique in the power industry. And the result is a product engineered for dependable, economical and efficient production of high-purity steam . . . and delivered as a package which keeps installation costs to a minimum.

Make planning your steam generator installation easier by getting full information on Foster Wheeler Packaged Steam Generators *before* you start writing your specifications. Write Foster Wheeler Corporation, 666 Fifth Ave., New York 17, for Bulletin PG-58-2. Or better still, contact Foster Wheeler directly and discuss your steam requirements personally with one of Foster Wheeler's *heat engineering* specialists.

Heat Engineered products, plants and processes . . . for the world's power, petroleum and process industries.

—SPECIALIZED INSTALLATIONS

FOSTER WHEELER

NEW YORK LONDON PARIS ST. CATHARINES, ONT.

For more facts circle 211 on Reader Service card, p 109

circle 212 on Reader Service card for following ad ▶

The Story of Edward Research

and the Leak-proof Valve

In the early 1940's, the advance of steam power plant pressures and temperatures demanded a leak-proof, small sized valve—one with permanent tightness at the seat joint and one which would solve the failures of mechanical gasketed bonnet joints under elevated temperatures. The story behind the development of the Edward leak-proof Univalve* (sizes to 2½" in 1500, 2500 and 4500 lb. pressure classes) is the story of the product research that solved this industry problem.

EARLY EXPERIMENTING: Elimination of the bonnet joint entirely, by providing a one piece body-yoke construction, appeared to be a logical approach to the bonnet joint problem. But this created a new problem—how to apply and *how to service* an integral Stellited seat from a distant point at the top of the valve yoke. Some valve manufacturers chose to split the valve body near the seat and then reassemble the body with a full pressure weld. Others chose a full pressure weld at the normal bonnet joint position. Neither approach allowed the user to disassemble the valve and both approaches resulted in the sacrifice of a positive, permanent backseat—a desirable feature in any high-pressure valve. Edward engineers refused to make these concessions.

ENGINEERS FIND SOLUTION: After many attempts, Edward engineers developed a water-cooled welding torch for the application of the Stellite seat. This provided a stress-free Stellite layer of uniform density, firmly bonded to the body, free of cracks and pin hole porosity. Simultaneously, other Edward engineers sought the answer to the bonnet joint leakage problem. Extensive research and testing of a variety of body-bonnet combinations and seal-welding techniques resulted in the four elements of today's proven Univalve bonnet joint—a body-bonnet shoulder, load carrying thread, guiding section for alignment and the seal weld.

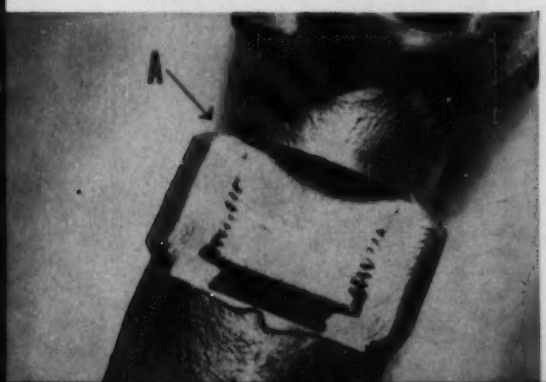
NEW DESIGN PROVES OUT: Months of research testing failed to find a weakness in the new design. Thousands of operations at rated pressure and temperature indicated long-time seat tightness superior to anything previously achieved. Bonnet joint design could not be made to fail at several times the valve rating. Tests were conducted with supercritical steam pressures up to 6000 psi at 1050 F in the only known facilities capable of producing those conditions at that time. And, to date, *hundreds of thousands of Univalves are in service with only one recorded instance of bonnet joint leakage*—a minor defect in the seal weld.

Edward builds a complete line of forged and cast steel valves from ⅛" to 18", in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs for pressures up to 10,000 lbs. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1230 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

EDWARD STEEL VALVES
another fine product by
ROCKWELL

◀ **E. A. STICHA,** Chief Research Metallurgist, and R. K. Wagenblast, Research Engineer, measure temperature of valve seal weld in superheater test loop used in Univalve research.

▼ **DESTRUCTION TESTS IN EDWARD LABORATORIES IN EARLY 1940's**—Bonnet seal weld (A) of test valve cracked only after body creep occurred at 200° F above primary temperature and four times the primary pressure.



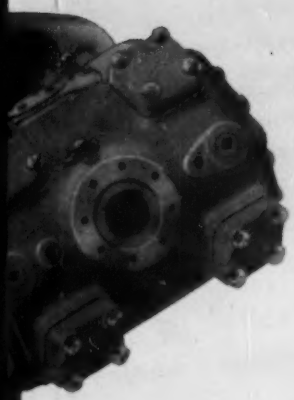
CRITICAL LEAKAGE PROBLEMS ATTACKED BY EDWARD RESEARCH ENGINEERS—(A) Bonnet leakage solved by design featuring threaded structural joint and seal weld; (B) Seat leakage solved by revolutionary Stellite seat welding technique.

*T.M. Reg. U.S. Pat. Off.

NEW
COOPER-BESSEMER
DMR-3 THREE-STAGE
AIR COMPRESSOR
FOR
SOOT-BLOWING
200 TO 400 HP

S. D. Greiner, *Air Compressor Sales Engineer,*
The Cooper-Bessemer Corporation, explains...

How Cooper-Bessemer's new, compact Air Compressors cut soot-blowing costs



Compressed air provides important cost savings for soot-blowing in coal or oil-fired power plants. Glance at the list of advantages shown at the right.

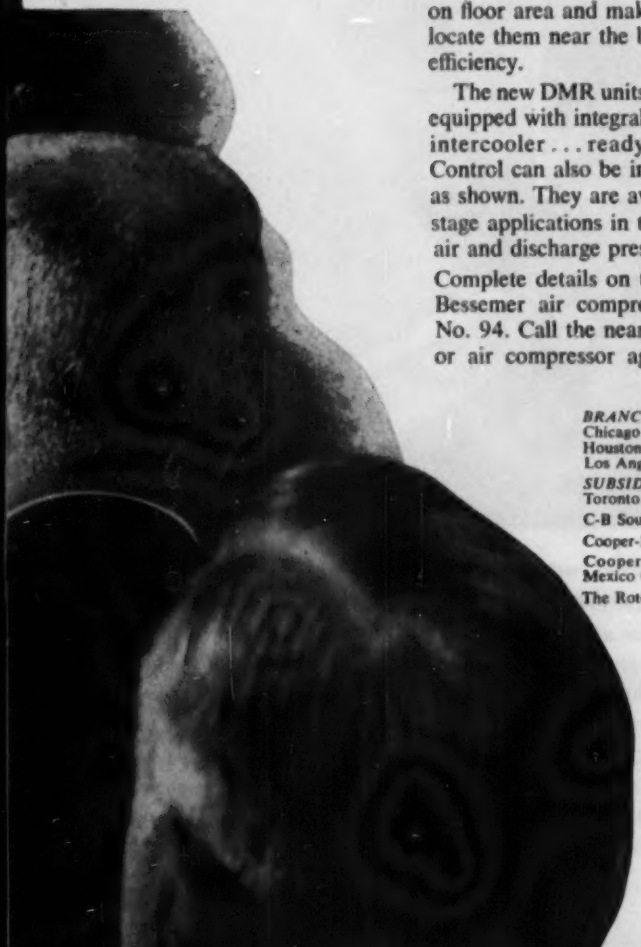
Now, Cooper-Bessemer introduces further economies in favor of AIR as the soot-blowing medium. The new line of DMR Air Compressors provides a new standard of *installation* economy. So highly *compact,* the DMR units can be installed in small space, conserving on floor area and making it possible to locate them near the boiler for greatest efficiency.

The new DMR units come completely equipped with integral motor-drive and intercooler... ready for operation. Control can also be integrally mounted as shown. They are available for three-stage applications in the range of 687 to 1029 cfm free air and discharge pressures of 350 and 500 psi.

Complete details on this new line of Cooper-Bessemer air compressors are given in Bulletin No. 94. Call the nearby Cooper-Bessemer office or air compressor agent for your free copy.

ECONOMICS OF BOILER CLEANING WITH COMPRESSED AIR (VERSUS STEAM)

1. Pressure is always adequate to do clean, thorough job.
2. Better programming with air... gets better cleaning results for higher boiler efficiency.
3. Lower cost for blowing medium ... less waste.
4. No quenching action on hot alloy tubes or pressure vessels.
5. Much less maintenance of blower equipment due to erosion, corrosion, packing wear.
6. Improved housekeeping... no steam or condensate leakage.
7. Greater over-all economy of blowing medium on evaluated basis.
8. Eliminates condensate makeup required when blowing with steam.



BRANCH OFFICES: Grove City • New York • Washington • Gloucester • Pittsburgh Chicago • Minneapolis • St. Louis • Kansas City • Tulsa • New Orleans • Shreveport Houston • Greggton • Dallas • Odessa • Pampa • Casper • Seattle • San Francisco Los Angeles

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C-B Southern, Inc.... Houston

Cooper-Bessemer International Corporation... New York • Caracas • Anaco

Cooper-Bessemer, S.A.... Chur, Switzerland • The Hague, Netherlands Mexico City

The Rotor Tool Company... Cleveland

Cooper Bessemer

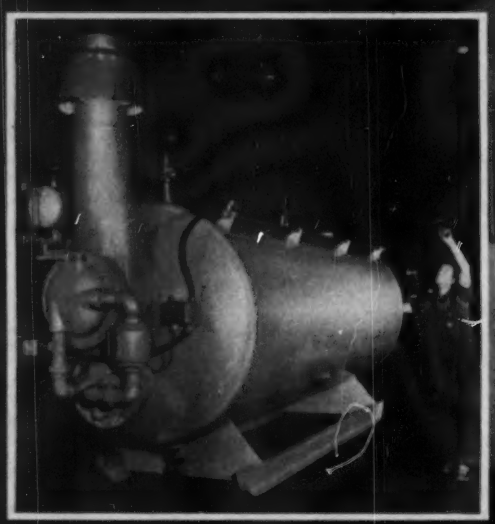
GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS • DIESEL • GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE, TURBINE OR MOTOR DRIVEN

For more facts circle 213 on Reader Service card, p 109

FIRST

INDIRECT GAS FIRED STORAGE WATER HEATER FOR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL USE



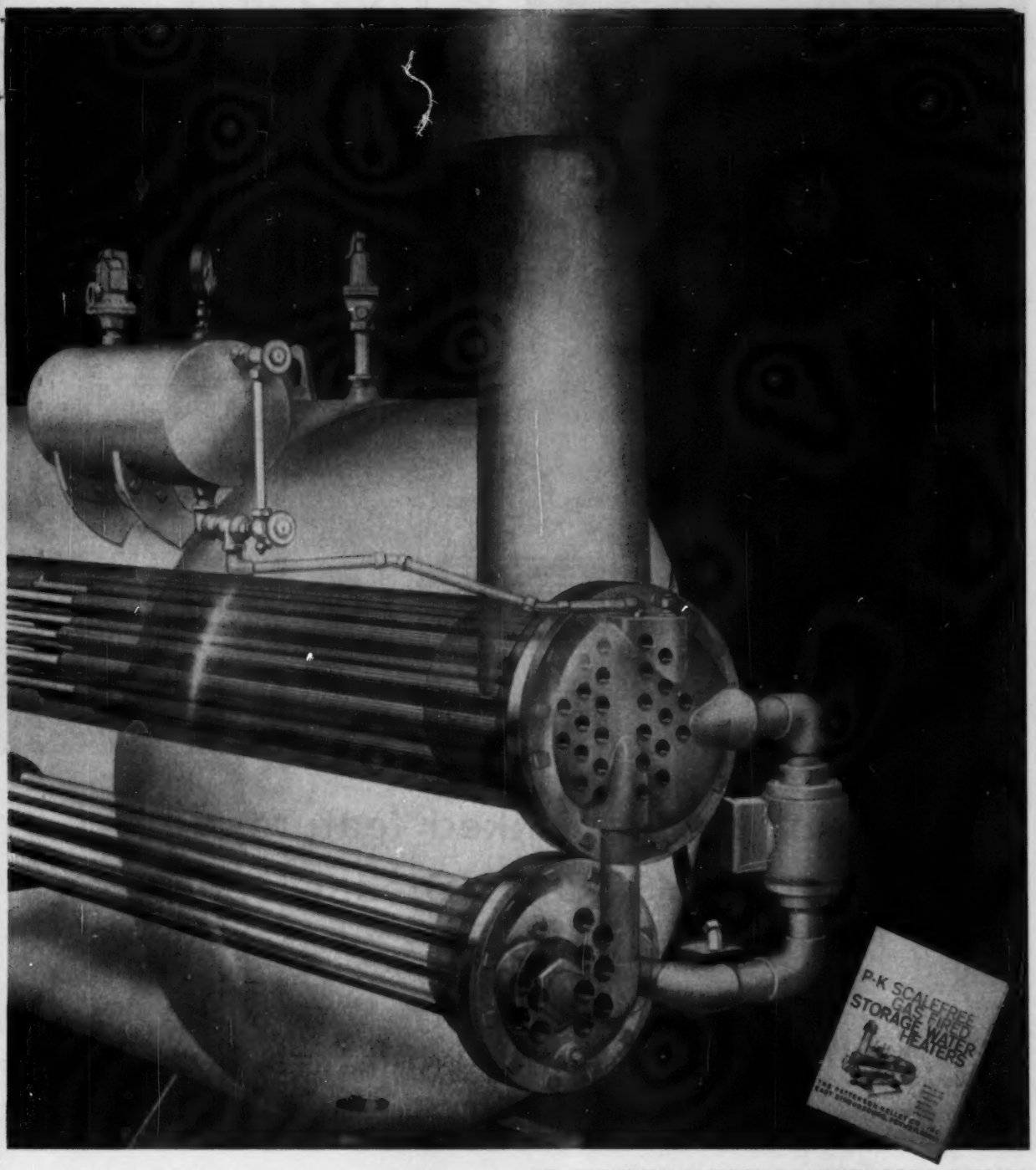
- *No scaling*
- *No drop-off in rated efficiency*
- *No fuel waste*
- *No on-the-job assembly*
- *No complicated maintenance*
- *No limitations on placement*
- *Fully automatic*
- *Copper heating surface*
- *Available in more than 100 storage and recovery combinations*

The first indirect gas fired design in storage water heaters is a rugged industrial type unit with finest controls and safeguards. It is backed by P-K's 80 years of experience in building and designing quality water heating equipment. Its name: SCALEFREE 230*.

P-K SCALEFREE 230 heats surface water through hot intermediate distilled water. Transfer occurs below the temperature at which minerals that cause scaling precipitate. Efficiency remains unimpaired throughout service life. Linings of Pre-Krete or copper are available to keep the unit free of rust and corrosion regardless of water conditions.

SCALEFREE 230 features a new P-K gas burner. It operates at maximum practical efficiency. Yet it gives almost noiseless service—does not rumble or boom on startup. This permits location almost anywhere in office buildings, institutions, schools, motels, etc.

SCALEFREE 230 is a complete fully automatic package that can be quickly set in place, hooked up, and checked out. It requires only simple electrical, water and gas connections. No stack is needed for extra draft—only a vent.



No foundation is necessary. A rugged skid-in type base is supplied. It is easily accessible for inspection. Tube bundles are removable.

SCALEFREE 230 is completely safe. It has a fail-safe chain of built-in protective devices. It is available in more than 100 storage and recovery combinations. Storage capacities range from 250 to 4000 gallons. Recovery sections range from 390,000 to 2,215,000 Btu. Send the coupon for complete information.

*Patent pending

Patterson Kelley

184 Morgan Ave., East Stroudsburg, Pa.

- ☐ Please send complete technical data on SCALEFREE 230
- ☐ Please have a P-K Sales Engineer call to discuss design and operational features.

Name_____ Position_____

Company_____

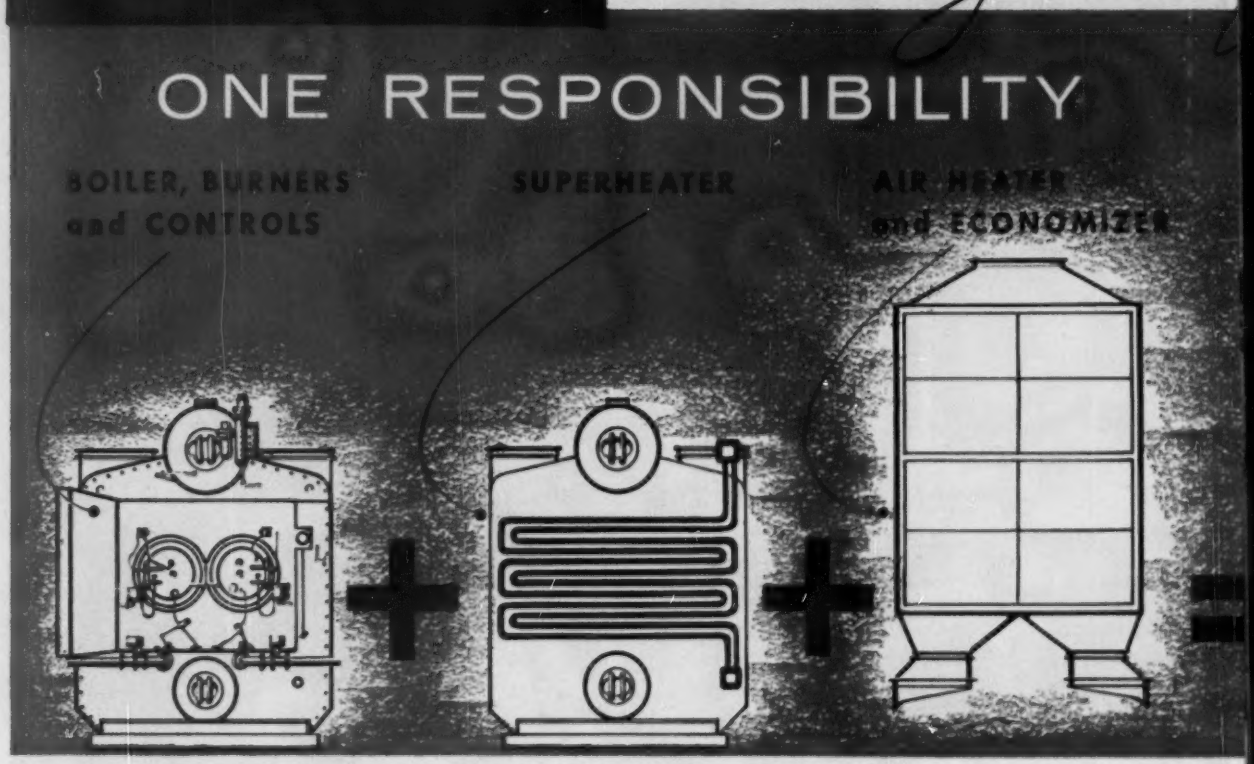
Address_____

City_____ Zone_____ State_____

For more facts circle 214 on Reader Service card, p 109

KEYSTONE *Package*

ONE RESPONSIBILITY

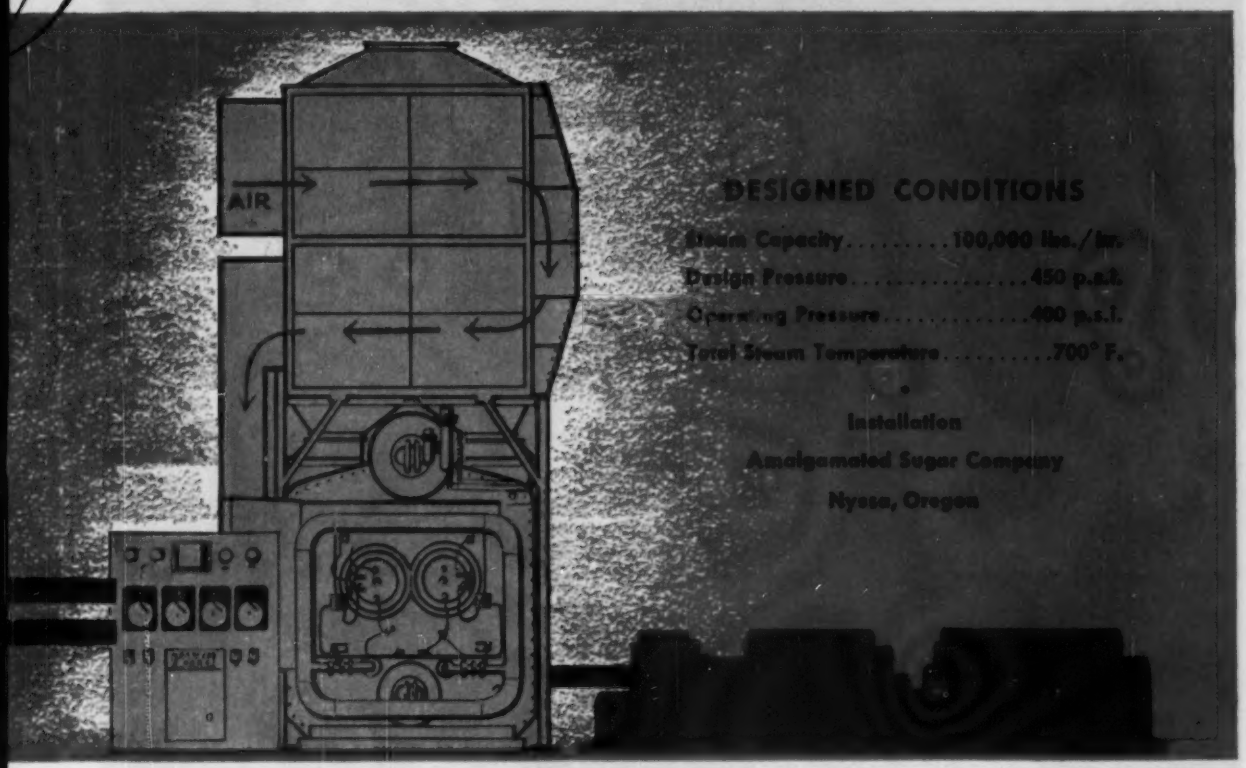


"Some of the best liked features of our KEYSTONE Steam Generator"

Amalgamated Sugar Company
Nyssa, Oregon

- Ease of installation
- The large turn-down ratio of the gas burners
- Fast response to steam demands
- Minimum space for maximum capacity
- Minimum of attention required for operation
- High over-all efficiency of unit

for Power Generation



Low Capital Investment

HERE ARE the power plant components normally associated with large field erected steam generators. These are packaged in a low cost, highly efficient installation. The boiler utilizes an integral Drainable Superheater to produce high temperature steam for use in a generating turbine. The Air Heater preheats the combustion air to provide efficiencies equal to utility standards.

Low first cost of this packaged installation saves considerable money over the cost of a similar field erected unit with no decrease in quality or efficiency.

If your problem is one of adding high pressure and high temperature steam for process work, power generation, or at low capital expenditure, to assist your present boilers during peak loads, then investigate Power Packages by Erie City Iron Works. Write for additional information in Bulletin SB-59-1-C.

You can depend on ERIE CITY Since 1840 *for sound engineering*

ERIE CITY IRON WORKS · Erie, Pa.

STEAM GENERATORS • SUPERHEATERS • STOKERS • PULVERIZERS
ECONOMIZERS • WASTE HEAT BOILERS • OIL and GAS BURNERS
AIR PREHEATERS • FIRE and WATER TUBE PACKAGE BOILERS

For more facts circle 215 on Reader Service card, p 109

NEW!

S-E-Co.
GRAVIMETRIC FEEDERS AND VOLUMETRIC FEEDERS GIVE UNIFORM RATE OF COAL FEED BECAUSE

- unobstructed 24" width of coal stream from inlet through to outlet assures better flow of wet and sticky coals.
- approximately 4-1/2" depth of coal on belt allows passage of occasional large pieces or frozen lumps of coal.
- high coefficient of friction of coal on rubber belts provides positive feeding of coal at the inlet.
- high belt tension prevents slipping of the belt on the head pulley.
- variable speed drive utilizes magnetic slip clutch with close speed regulation.
- in S-E-Co. gravimetric feeders, the rate of feed is controlled by weight, thus eliminating the variability of coal density.

For better feeding of coal to pulverizers and cyclones write to

STOCK Equipment Company
725 HANNA BUILDING • CLEVELAND 15, OHIO

For more facts circle 216 on Reader Service card, p 109

any way you look at it...

YARWAY REMOTE LIQUID LEVEL INDICATOR GIVES BRIGHT, INSTANT, ACCURATE READINGS

On its brilliant "wide vision" dial you can clearly read the level from any point in a 180° arc—and from a considerable distance.

Remote readings of levels in boilers, feed water heaters and other heat exchangers are instant and accurate because indicator operating mechanism is actuated by the varying head of the liquid itself, yet the pointer mechanism is never under pressure.

Yarway Indicators may be arranged to operate remote Yarway Electronic Secondary Indicators or remote Hi-Lo Alarm Signals (lights or horns) located anywhere in the plant.

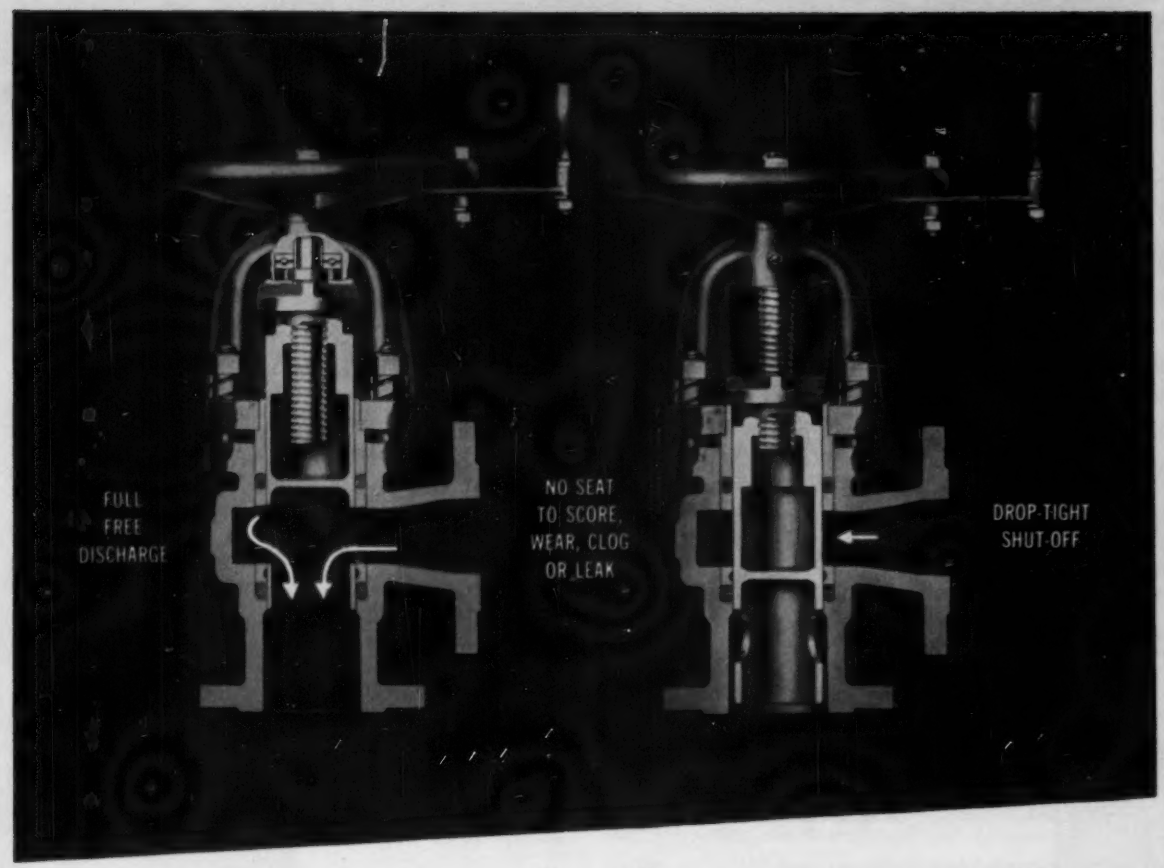
A record of nearly 13,000 successful installations speaks for itself.

For details on construction, operation, installation and typical hook-ups, write for Yarway Bulletin RI-1825.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

For more facts circle 217 on Reader Service card, p 109



open and shut case!

...FOR TROUBLE-FREE PERFORMANCE WITH YARWAY SEATLESS BLOW-OFF VALVES

Mention Yarway Seatless Blow-Off Valves in more than 16,000 boiler plants, and you'll get solid approval—for these plants have first-hand *experience* with the dependable, trouble-free, service of Yarways.

For boiler blow-down service at all pressures up to 415 psi, YARWAY SEATLESS (in tandem) is the popular choice.

Outstanding feature is the famous seatless design—*there is no seat to score, wear, clog or leak*. Nitralloy hollow sliding plunger permits full, free discharge, yet keeps valve drop-tight in closed position. *No other blow-off valve has these features.*

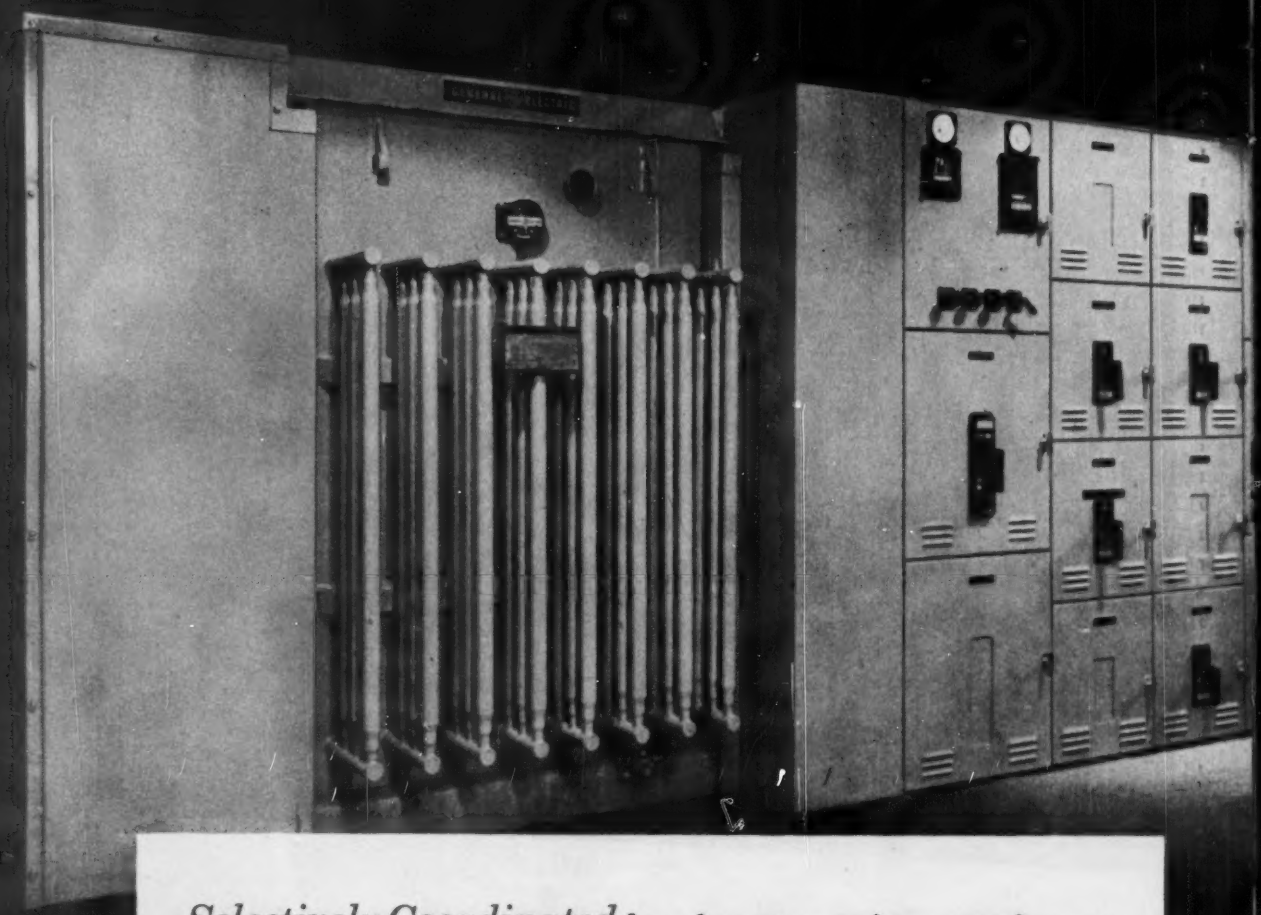
Specify Yarway Seatless Valves when ordering new boilers and when replacing worn or inefficient blow-off valves on your present boilers.

Yarway Bulletin B-427 gives full information. Write for it today.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

For more facts circle 218 on Reader Service card, p 109



Selectively Coordinated **load centers give maximum service continuity . . . and now cost you less**

1. **SAVE UP TO $600 PER BREAKER** because General Electric has eliminated the price premium for selective trips when supplied with G-E switchgear equipments.

2. **SAVE UP TO $630 PER BREAKER** by using manually operated, stored-energy breakers in place of electrical units formerly required.

Total savings vary from $465 to $930 per breaker, depending on size.

How much can you save? Ask your General Electric sales engineer.

General Electric *Selectively Coordinated* Load Center Unit Substations now are . . .

Yours at Lower Cost

YOU NOW PAY LESS

You can purchase G-E *Selectively Coordinated* load center unit substations at new low prices. General Electric has eliminated the price premium normally charged for this inherently higher-cost, more highly-engineered product. This means that you can now get superior service for the same price as the more common, but less "intelligent," fully-rated load center unit substation. Further savings can be realized by the use of manually operated stored-energy breakers.

SELECTIVELY COORDINATED LOAD CENTERS MINIMIZE DOWNTIME

In the *Selectively Coordinated* load center, the tripping times of the main and feeder breakers are coordinated so that during short-circuit conditions, power is removed only from the faulted feeder. Power continues to flow to the unfaulted feeders—thus preventing costly, unnecessary downtime. (See diagram below.)

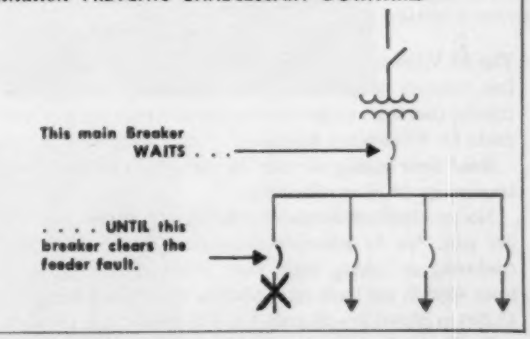
SIMPLY SPECIFY SELECTIVE COORDINATION

Order the *Selectively Coordinated* load center. Upon delivery, you will receive time-coordination curves which show you the factory-preset characteristics of each breaker, how they combine to assure you of the best possible service continuity.

For more detailed information, contact your nearest G-E Apparatus Sales Office or write to General Electric Co., Schenectady 5, N. Y. for bulletin GEA-3592. 331-01

HOW Selective Coordination PREVENTS UNNECESSARY DOWNTIME

WITH G-E SELECTIVELY COORDINATED load center unit substations, feeder breakers are adjusted to clear any magnitude of feeder fault. The selective main breaker preserves power continuity to unfaulted feeders.

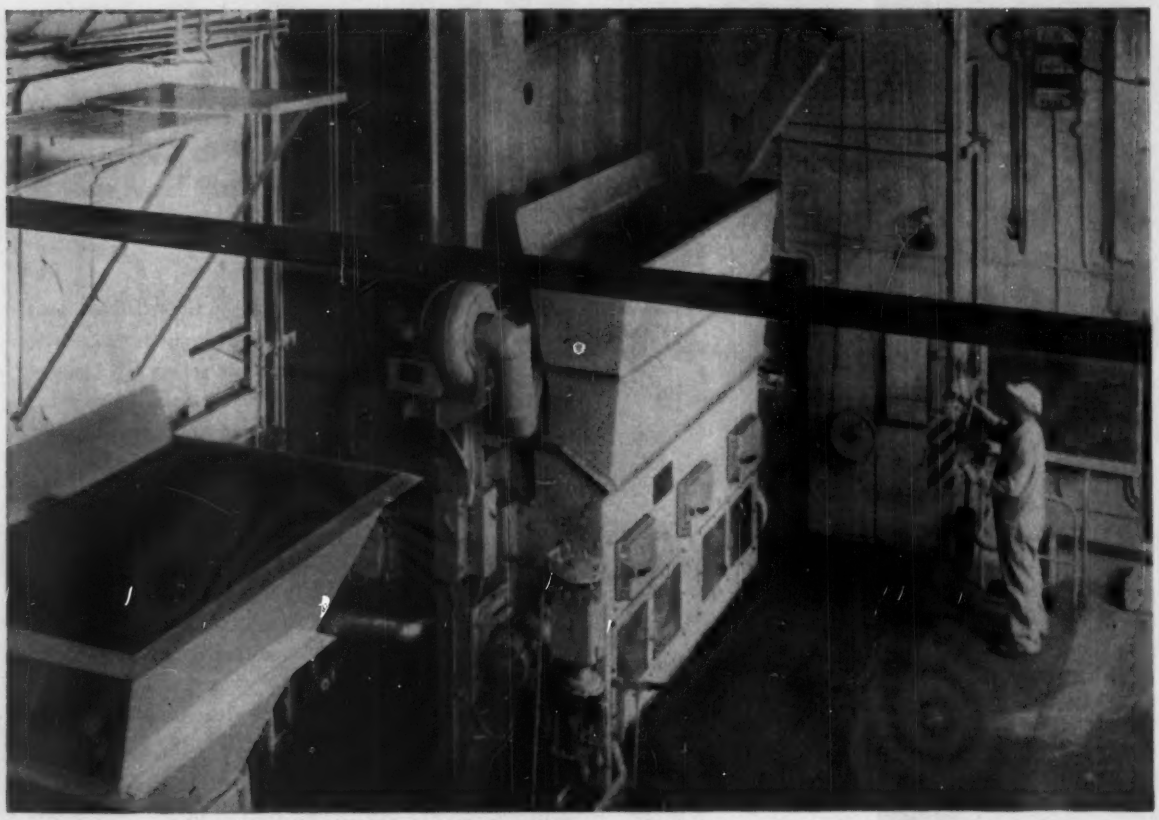


Progress Is Our Most Important Product

GENERAL ELECTRIC

For more facts circle 219 on Reader Service card, p 109

at S. C. Johnson & Son, Inc.



On the line in October 1954, this 40,000-lb B&W boiler, fired by AE Vibra-Grate Stoker, has never had an unscheduled shutdown. Cost of repairs to previous stokers ran close to $1000 per year.

Five-year repair bill for Vibra-Grate Stoker...only $188!

(vs previous stoker costs of $1000 a year)

The AE Vibra-Grate Stoker installed at S. C. Johnson & Son, Inc. (makers of Johnson's Wax Products), Racine, Wisconsin, continues to prove every performance promise ever made for Vibra-Grate Stokers.

Read these highlights from the company's *five-year* maintenance report, just released:

No unscheduled shutdowns. Savings of 919 tons of coal per year. No fly ash collector needed. No trouble with clinkering or coking coals. Peak efficiency at plant loads from 4000 lb per hour to 45,000 per hour. Load swings of 15,000 to 20,000 lb with only 3 to 4 lb variation in pressure.

Finally, total repair costs only $188, while burning 34,962 tons of coal . . . just slightly over ½ cent per ton of coal!

The AE Vibra-Grate Stoker is the only stoker which combines the long life and low maintenance of water-cooled grates with the high efficiency of vibrating grate feed and controlled zone undergrate air. No other stoker cuts maintenance costs so drastically, gives such highs in efficiency. Get the complete design and operating story. Write today to Dept. **S-100** for our Vibra-Grate Stoker Catalog S-546-A.

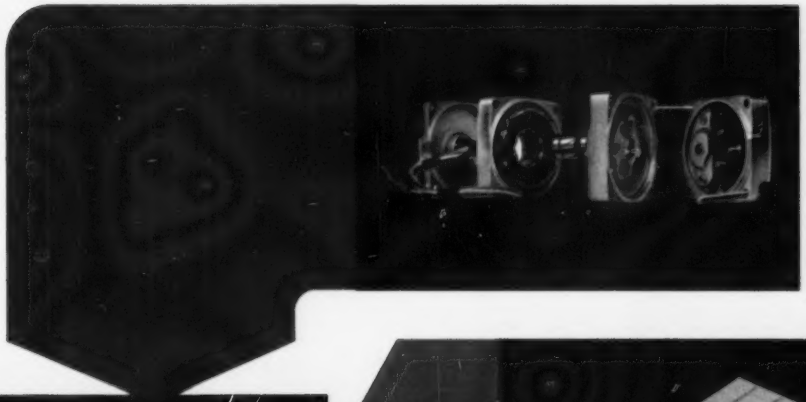
AMERICAN ENGINEERING COMPANY
Wheatsheaf Lane & Sepviva St. • Philadelphia 37, Pa.

Canadian Subsidiaries: Affiliated Engineering Corporation, Ltd., Montreal, P. Q. • Bawdin Industries Ltd., Toronto, Ont.

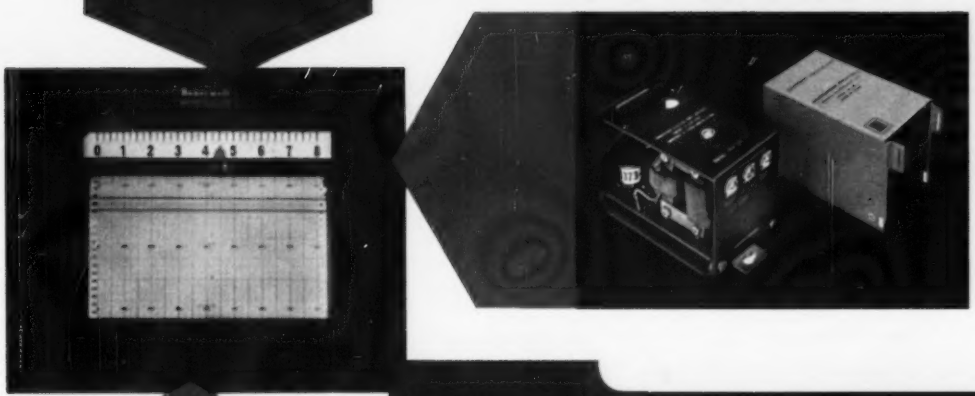
For more facts circle 220 on Reader Service card, p 109

Circle 221 on Reader Service card, p 109 ➤

MODULAR DESIGN MAKES 1960 *ElectroniK* POTENTIOMETERS A GREATER VALUE THAN EVER



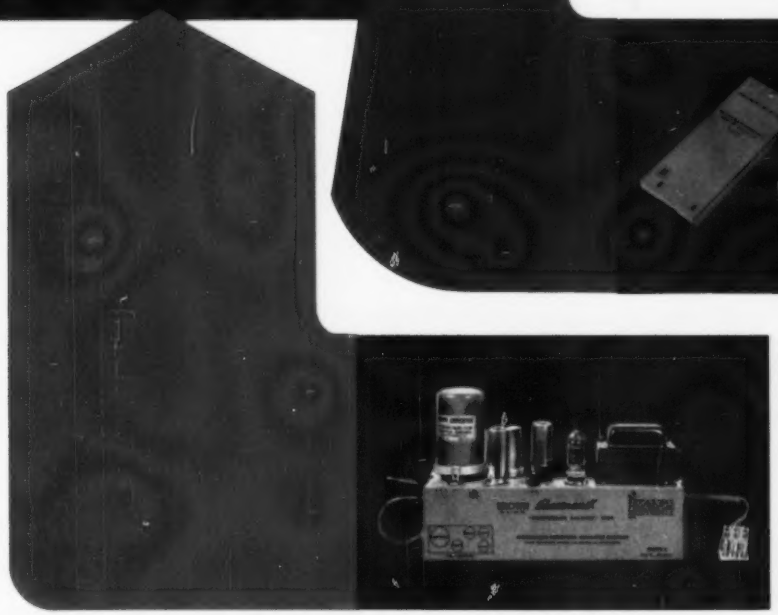
BALANCING AND CHART DRIVE MOTORS are sectionalized. Service is simplified because any major part can be replaced in a matter of seconds.



CONSTANT VOLTAGE UNIT* eliminates need for batteries, standard cells, and standardizing mechanisms . . . insuring long life.

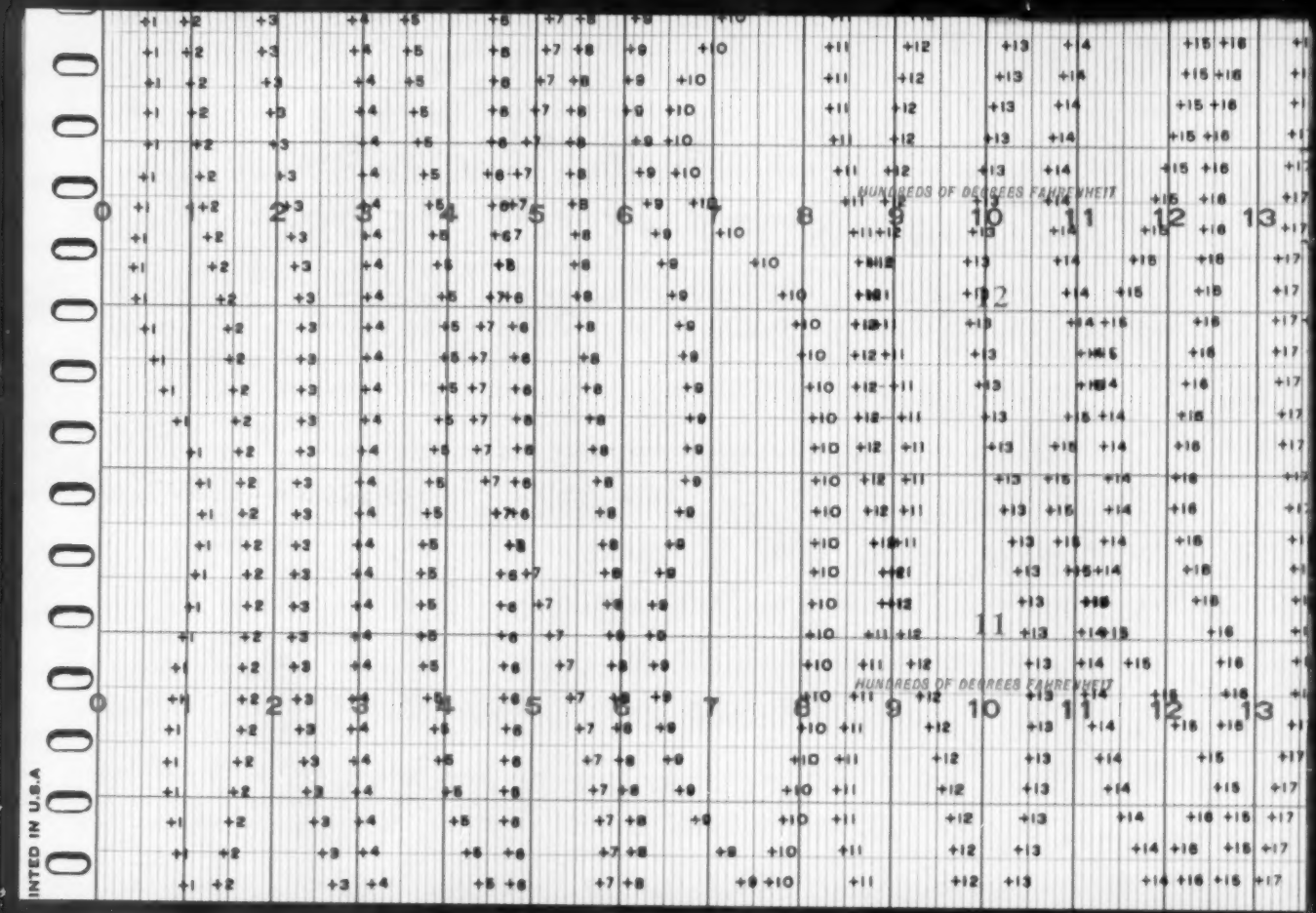
*Zener Diode

COMPARTMENTED MEASURING CIRCUIT UNIT makes range changing easy. Change one screw on a clip connected card of fixed resistors, and the job is done in a matter of seconds.



QUICK-CONNECT AMPLIFIER is easily removed from the instrument by means of a polarized plug.

BUT THIS IS JUST PART OF THE STORY OF THE 1960 LINE OF ELECTRONIK POTENTIOMETERS.
LOOK AT THE DRASTIC CHANGES IN THE ELECTRONIK MULTI-RECORD RECORDERS.


HUNDREDS OF DEGREES FAHRENHEIT
0 1 2 3 4 5 6 7 8 9 10 11 12 13
12
11
10
INTED IN U.S.A

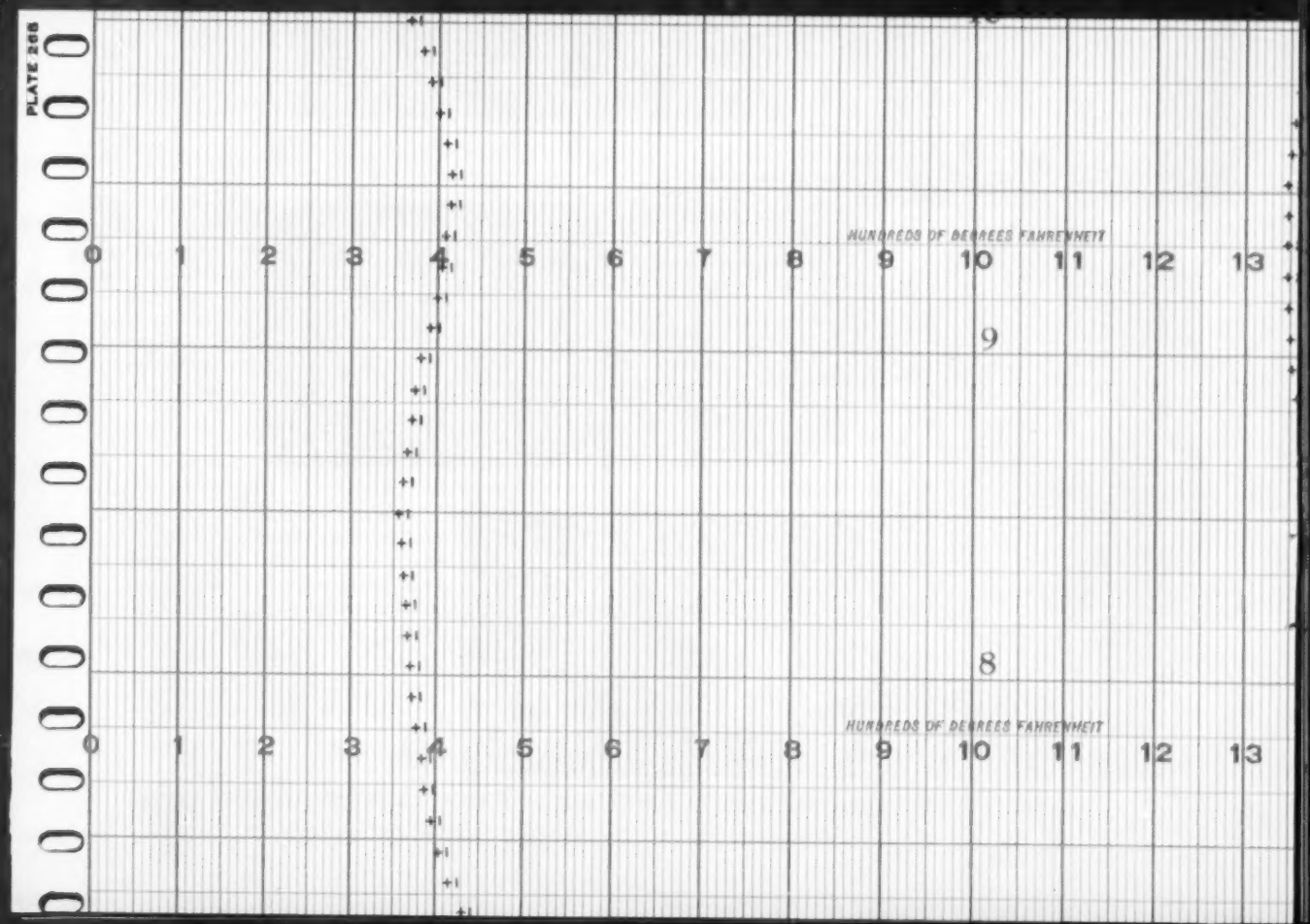
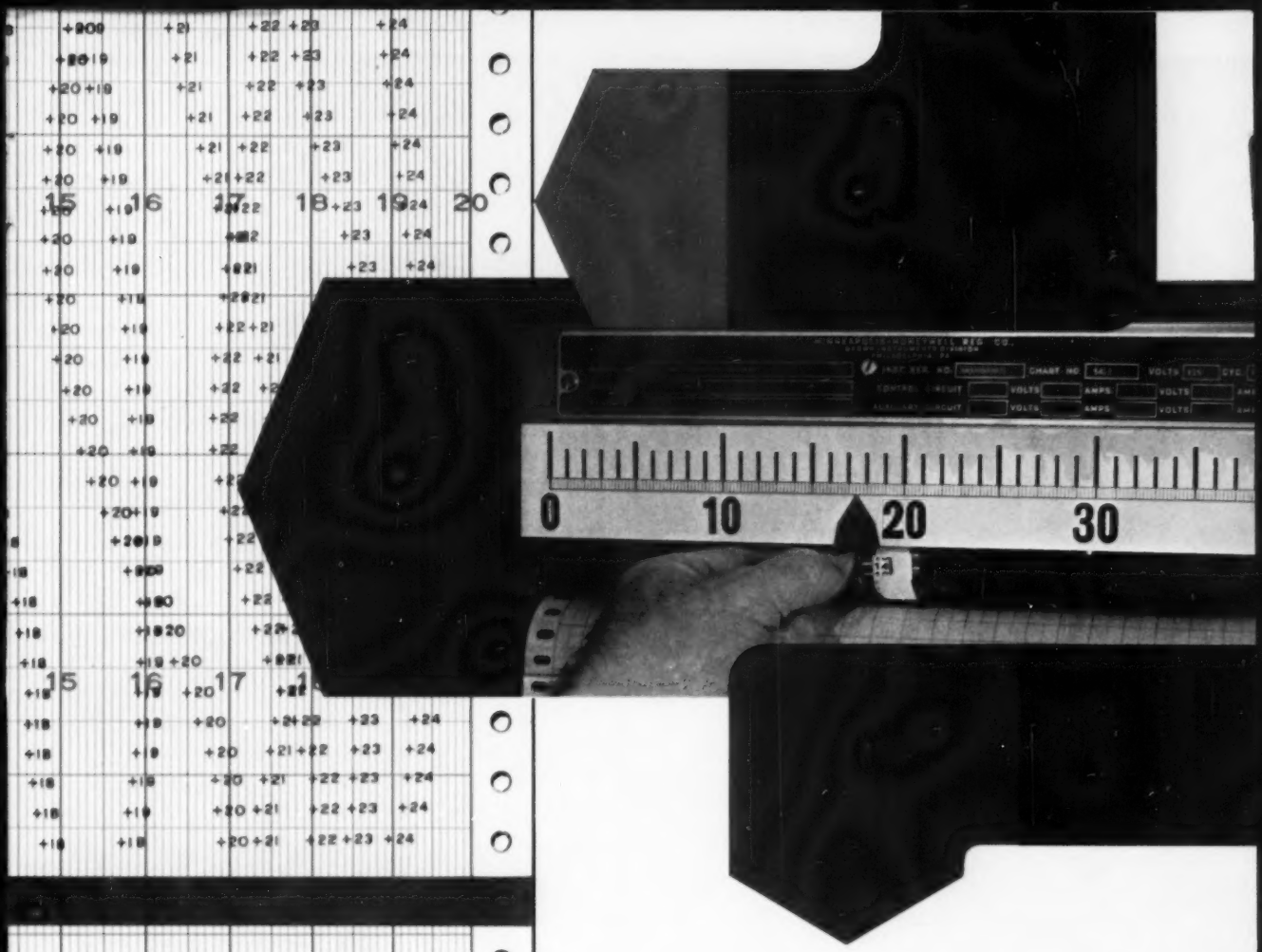


PLATE 268
HUNDREDS OF DEGREES FAHRENHEIT
0 1 2 3 4 5 6 7 8 9 10 11 12 13
9
8



Record 2 to 24 points on one instrument with new UNIVERSAL *ElectroniK*

MULTI-RECORD INSTRUMENT

Now, you can record 2,3,4,6,8,10,12,16,20, or 24 points on one ElectroniK Multi-Record Instrument . . . and change the number of points to be recorded in a matter of seconds. It's easy as this: remove a thumb-tight nut and slip off old print wheel . . . and indicator dial. Slip on a new wheel and dial: Replace nut. Plug in the number of points desired, and the job is done.

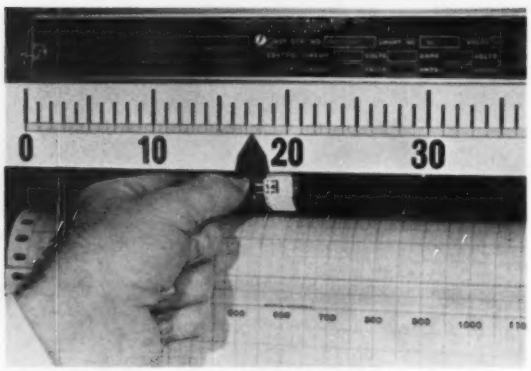
The universal features and modular design of the 1960 line of ElectroniK potentiometers are standard on all multi-record non-control models. Range and compensation changes are quick and easy, too . . . just change the cards.

FROM HONEYWELL... A DIAMOND JUBILEE PARADE OF PRODUCTS

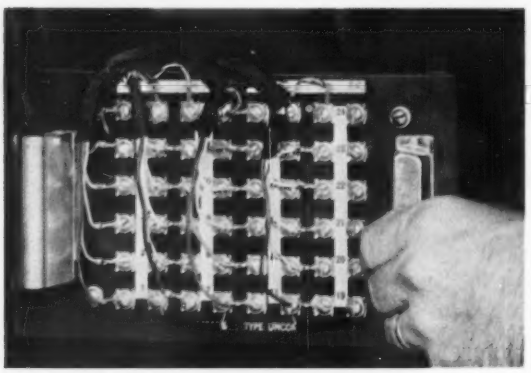
SEE HOW EASY THE 1960 ELECTRONIK MULTI-POINT RECORDERS ARE TO USE...

all it takes with the 1960 *ElectroniK* MULTI-RECORD RECORDERS to change . . .

. . . number of points recorded



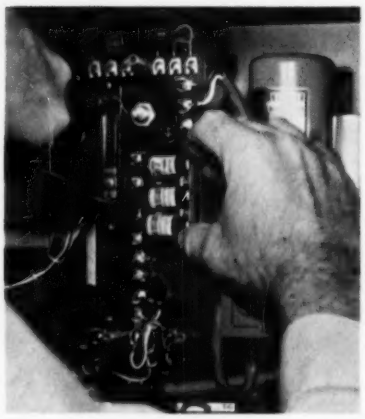
First: remove thumb-tight nut; slip off print wheel and indicator dial. Slip on new wheel and dial and replace nut.

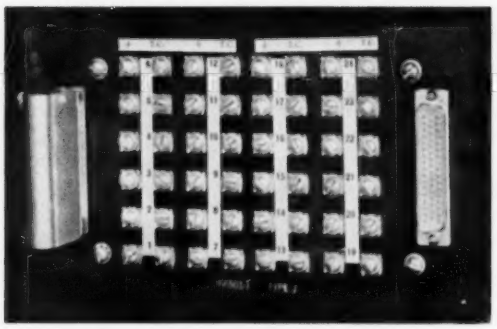


Second: replace one plug-in unit and the instrument is ready to record a different number of points.

The new flexibility and convenience of the 1960 ElectroniK Multi-Record Recorders should interest you. This new design has resulted in substantial manufacturing cost reductions which are reflected in our new price structure. Your nearby Honeywell field engineer has the full details. He's as near as your telephone. Minneapolis-Honeywell, Wayne and Windrim Avenues, Philadelphia 44, Pa.

. . . RANGE—Loosen screws and slide out the range resistor card. Replace with a different card, tighten screws and the job is done quickly and easily.





. . . COMPENSATION—The input terminal board with built-in reference junction comes out by removing one plug. Slide in the new board, replace the screws and plug and the compensation is changed.

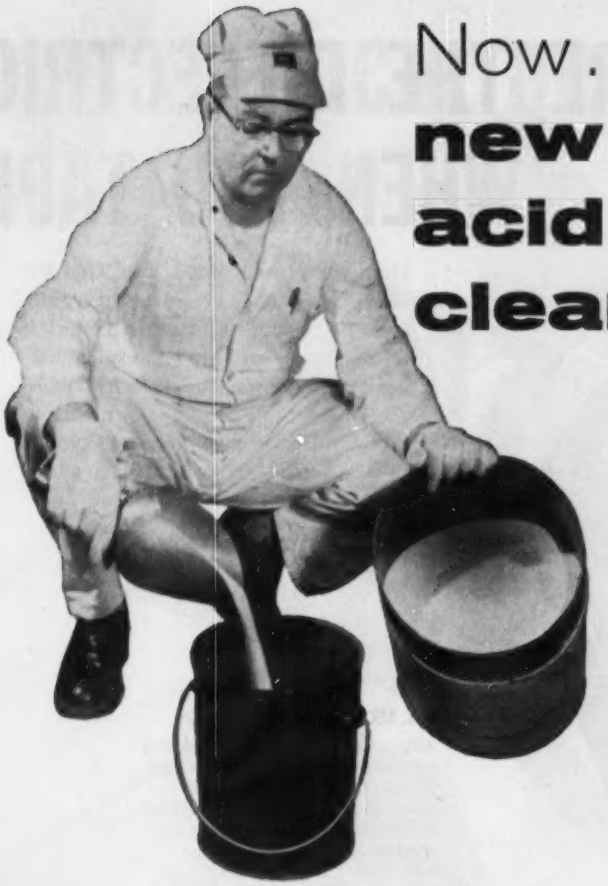
Honeywell

First in Control

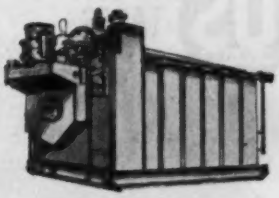
SINCE 1885

75th YEAR

PIONEERING THE FUTURE



Now... new acid cleaners



Steam Boilers, Condensers, Heat Exchangers, Piping

Air Conditioning Cooling Towers, Ice-Making Machines, Evaporating Condensers

Food-Processing Vessels, Pipelines, Gelatin Evaporators

Marine Salt-Water Evaporators and Heat Exchangers

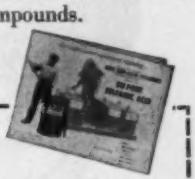
in **dry** easy-to-handle form

Cleaners based on Du Pont Sulfamic Acid are safer, more convenient, non-fuming... dissolve in water to form effective, low-corrosive solutions

Now... acid cleaners you handle *dry!* No fumes or hazardous liquid spillage to worry about. When mixed with water, these cleaners have all the penetrating power of hydrochloric acid with far less corrosive effect. The key to these unusual properties is a remarkable new ingredient — Du Pont Sulfamic Acid.

Sulfamic acid-based cleaners remove scale and deposits from air conditioning and ice-making equipment; food-processing vessels; steam boilers; milk evaporators and pasteurizers; marine evaporators and heat exchangers. Cleaning action is fast, thorough. Downtime is eliminated in many cases because cleaners are added while equipment is in operation.

We'll gladly send you additional information on sulfamic acid-based cleaners and the names of formulators who offer these new compounds. Just mail the coupon below.



DU PONT
SULFAMIC ACID

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

E. I. du Pont de Nemours & Co. (Inc.)
Industrial & Biochemicals Dept., N-2533P
Wilmington 98, Delaware

Please send me ☐ sulfamic acid general equipment cleaning bulletin; ☐ names of formulators offering cleaners based on sulfamic acid.

*Name*_____

*Company*_____

*Address*_____

*City*_____ *State*_____

US RUBBER TAPES

YOU RESTORE THE DIELECTRIC WHEN YOU TAPE

Here are famous brands preferred by electricians wherever wire or cable must be repaired in utilities, factories or mining service. After the splice has been made, restore the dielectric qualities of your original insulation with a rubber tape and then protect its physical and abrasion resistance by an additional covering of friction tape.

U. S. SECURITY FRICTION TAPE

Although competitively priced, this outstanding grade of electrical and general-purpose tape has all the characteristics of higher priced tape. It contains no pinholes—does not ravel when unwound from the roll—tears straight.

U. S. SECURITY RUBBER TAPE

The ideal commercial quality of unvulcanized rubber tape for all general electrical work.

U.S. Security rubber splicing compound possesses all the necessary physical properties: tensile elongation, tackiness and dielectric strength required for good, durable splices.

It is easy to handle and will fuse into a solid mass without the application of heat or undue pressure.

AND PHYSICAL QUALITIES WITH "U.S."

U. S. HOLDTITE® FRICTION TAPE

Contains no free sulphur or other ingredients injurious to metals or fabrics. Exceeds all the physical requirements of the A.S.T.M. specification. Handles cleanly without raveling or waste—has no pinholes—has high dielectric strength for high voltage jobs.

It has unusually high tensile strength and strong adhesion and makes splices that are durable and lasting.

U. S. HOLDTITE SPLICING COMPOUND

A high-grade rubber splicing compound exceeding A.S.T.M. requirements.

U. S. Holdtite rubber splicing compound is economical when considered on a cost-per-splice basis. Its high dielectric strength, combined with its fine tackiness and fusing qualities, assures perfect splices.

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

For more facts circle 223 on Reader Service card, p 109

HUGE 16" CRANE ANGLE VALVES

equipped with LimiTorque MOTORIZED VALVE OPERATORS

. . . in Thomas H. Allen Generating Station of MEMPHIS POWER & LIGHT DIVISION

Send for complete catalog L-550, and please use your Business Letterhead when requesting a copy.

These giant valves, the largest ever made of their type, stand 11 feet high and weigh 11,000 lbs. each — they were designed and built for an operating pressure of 2840 p.s.i. and required the development of a larger LimiTorque Motorized Valve Operator than any previously used, in order to provide the half million pounds of thrust required for operation . . . this is *another "first" for LimiTorque.*

In addition to using these huge 16" valves, this 862,500 k.w. generating station (one of the World's largest) is equipped almost throughout with other Crane Valves of varying sizes and types, many of which are also operated by LimiTorque Controls.

Remember, far more valves throughout the World are operated by LimiTorque than any other operator . . . There are many reasons for such widespread acceptance.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

PHILADELPHIA GEAR CORPORATION
KING OF PRUSSIA (SUBURBAN PHILADELPHIA), PA.
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS
Limitorque Corporation • King of Prussia, Penna.

ALLIS-CHALMERS

A-1244

Microscopic view of common algae found in cooling systems.

Allis-Chalmers No. 120 Series Algaecide brings

death to all algae

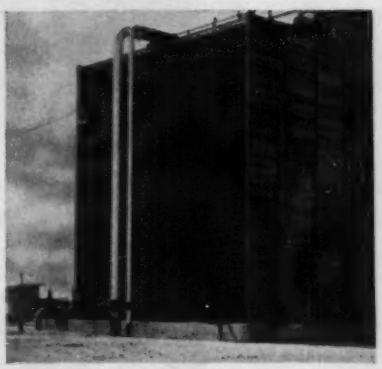
Lethal to more algae than any other algaecide! Only 2 to 5 ppm of this amazingly effective liquid does the job . . . proves the ideal solution to problems of plugged pump strainers, fouled heat exchanger tubes and coated cooling tower slats.

No expensive feeders needed . . . no application specialists required. Use pump, drip-feed or manual feed.

Safe? Even in its concentrated form, Allis-Chalmers No. 120 Series Algaecide is only a mild irritant to skin and hands. Economical, too, since there's no loss of its toxic quality on passage through the tower.

No worries about harmful side effects. Has low toxicity to fish or animals and is nonoxidizing and corrosion inhibiting. Developed after a thorough program of research and field testing—proved in over 4 years of use as the most toxic to all known organisms in cooling systems.

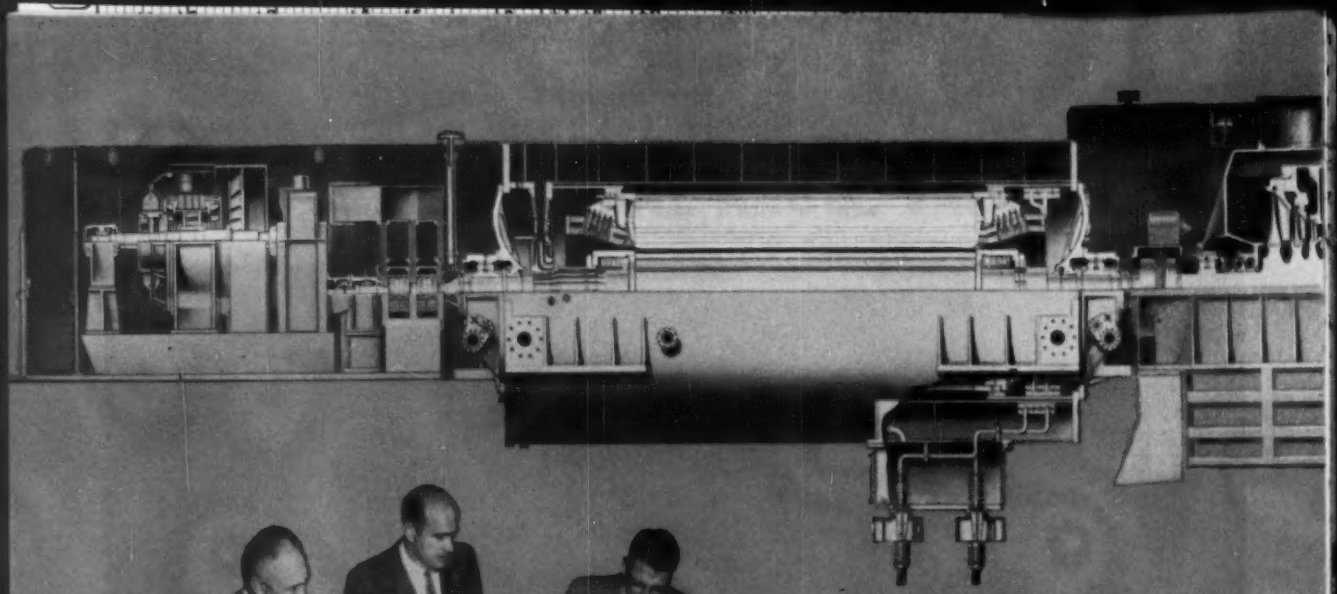
You can purchase No. 120 Series Algaecide directly from your nearby Allis-Chalmers office or write **Allis-Chalmers,** Power Equipment Division, Milwaukee 1, Wisconsin, for help on any of your water conditioning chemicals, equipment or service problems.



Scale and corrosion problems in cooling systems are covered in Allis-Chalmers Informational Bulletin No. 74-A, "Water Treatment for Cooling Towers." Write for your copy today.

For more facts circle 225 on Reader Service card, p 109

Circle 226 on Reader Service card for following ad ➤

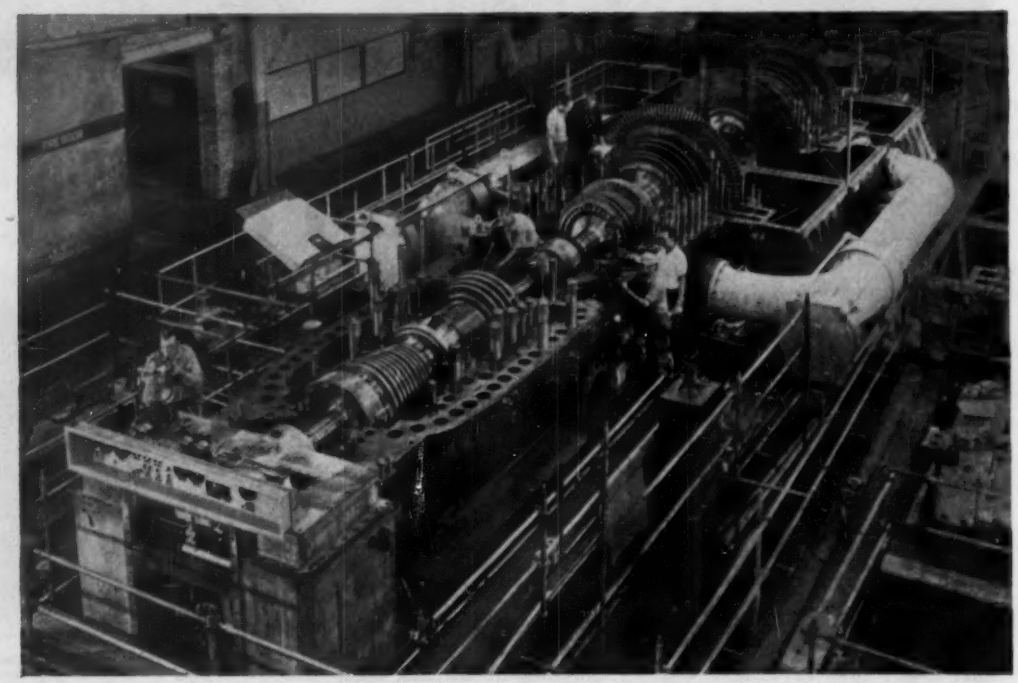


Design Firsts by Allis-Chalmers

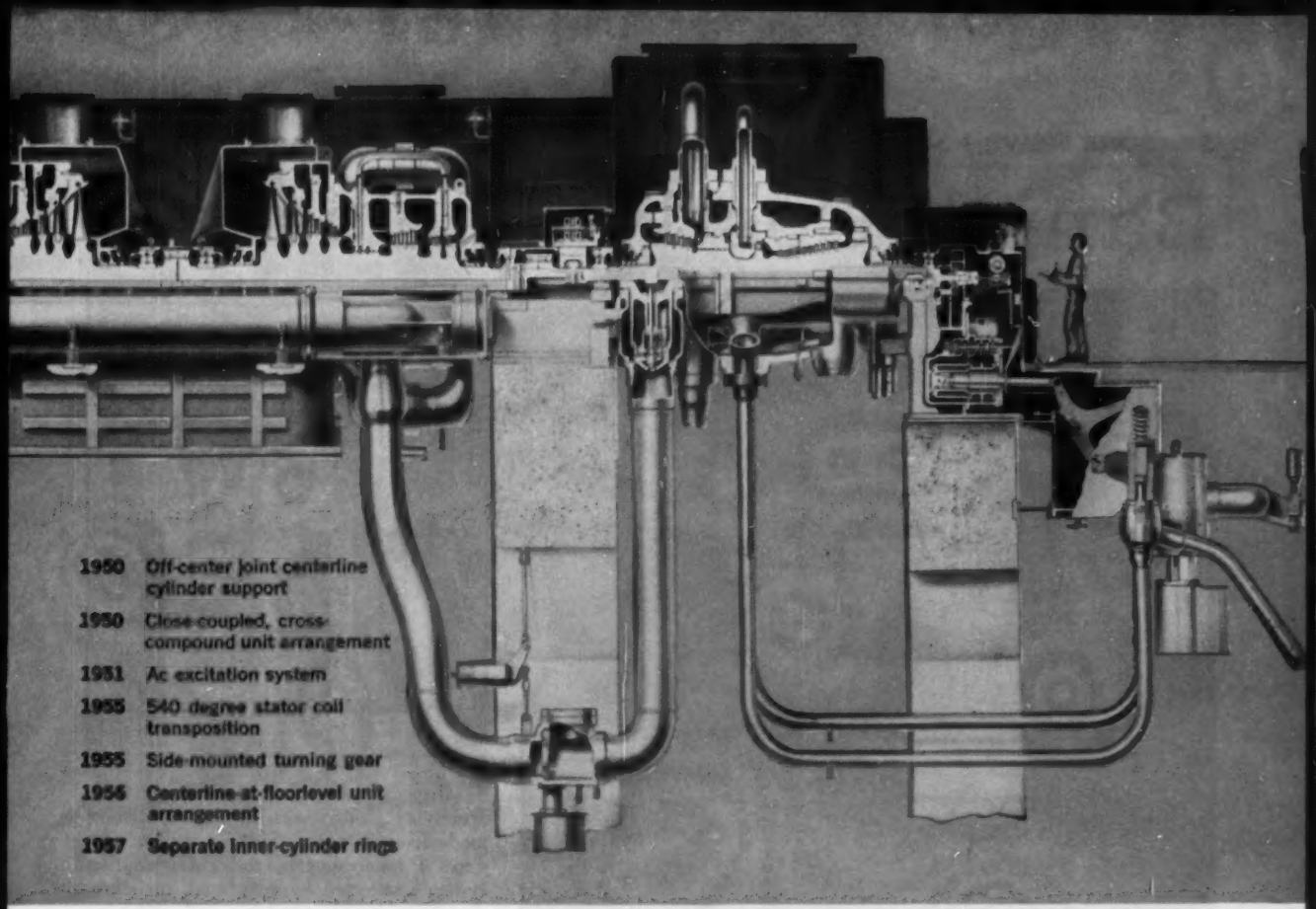
1925	Side-crossunders
1934	Separate nozzle chests
1936	Thrust-type hydrogen seals
1941	Nonsliding thrust-bearing pedestals
1948	Supercharged axial ventilation

Designing today for tomorrow's power needs, Allis-Chalmers experienced, forward-thinking engineering staff has pioneered higher ratings and unique arrangements for steam turbine-generator units . . . originated and patented many of the design features now adopted as industry standards for such equipment.

PACING



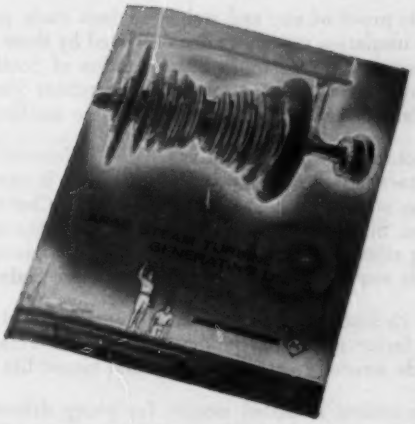
Engineering know-how and the results of extensive research and development programs are confirmed on the large turbine test pits. During the past few years A-C has spent millions of dollars expanding and modernizing manufacturing facilities like these to assure that design excellence created on the drawing board is translated into the finished product.


1950 Off-center joint centerline cylinder support
1950 Close-coupled, cross-compound unit arrangement
1951 Ac excitation system
1955 540 degree stator coil transposition
1955 Side-mounted turning gear
1956 Centerline-at-floorlevel unit arrangement
1957 Separate inner-cylinder rings

POWER PROGRESS ...by design!

An Allis-Chalmers tandem triple-flow steam turbine-generator unit, for example, incorporates such industry-recognized A-C developments as . . . centerline-supported inner and outer high-temperature cylinders; thrust-balanced turbine elements with high-temperature steam confined to a single shaft of small diameter; separate below-floor front-mounted steam chest; and separate ring-type nozzle chest in a center-inlet high-pressure turbine. Also, hydrostatic thrust-bearing-type shaft seals for the fully supercharged generator.

These advanced design concepts add to Allis-Chalmers growing list of firsts — set new industry standards for performance and continue the pattern by which A-C paces power progress . . . ahead of utility requirements.



NEW BULLETIN

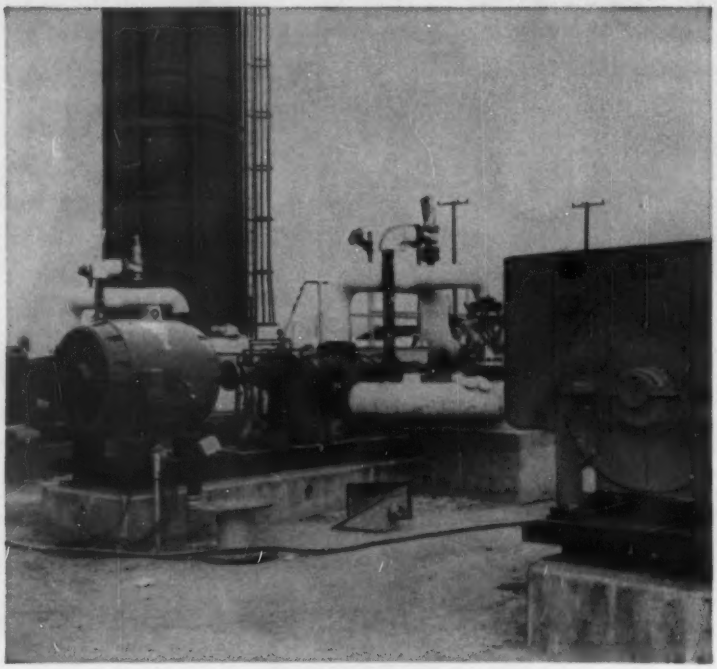
For more information on these and other outstanding design features of Allis-Chalmers line of reheat steam turbine-generator units, contact your nearest A-C office for Bulletin 03B9448. Forty pages, illustrated by more than 100 photographs, tell how A-C is pacing power progress.

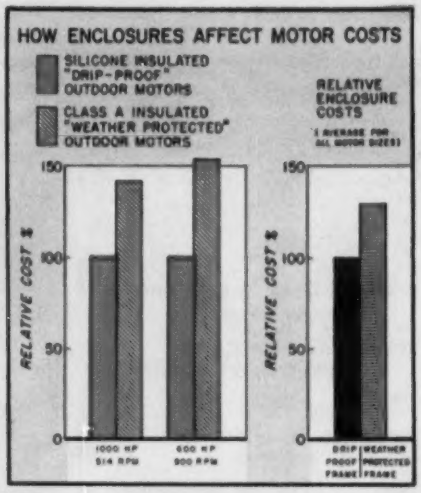
A-C ALLIS-CHALMERS

A-1212

SILICONE NEWS from Dow Corning

Banish Costly Enclosures





Save on Outdoor Motors by Specifying Silicone Insulation

Dramatic proof of size and weight savings made possible by motors with silicone insulation systems is demonstrated by these outdoor direct coupled pump drives at the Alamitos Steam Station of Southern California Edison Company. Here, self-protecting silicone rubber insulation means substantial dollar savings in enclosure cost for the smaller, open frame motor.

Both motors have 400-hp ratings. The difference in weight between the two motors is well over 1,000 pounds. Why is one motor so much larger than the other? Because the smaller Allis-Chalmers motor has a self-protected Silco-Flex insulation system incorporating Silastic®, the Dow Corning silicone rubber. The other motor is insulated with conventional materials requiring the protection of a more elaborate enclosure.

Despite its much smaller size, the silicone insulated motor also has a 15% service factor not found in the larger unit. This extra cushion against overloads assures greater reliability and longer life for the smaller unit.

Silicone rubber insulated motors for pump drives, fan drives, or other applications can withstand torrential rains, corrosive fumes, fly ash, dust, salt air, snow, sleet, cold, heat . . . even flooding! That's why it's wise to specify motors with insulation systems made from Dow Corning Silicones for greater reliability and maximum savings.

For more information, write Dept. 6903.

Savings of 30% and better result from specifying motors with insulation systems made from Silastic. Silicone rubber produces a homogeneous, resilient insulation system unaffected by heat, cold, moisture, abrasives, many chemicals and corrosive atmospheres. No need to buy expensive enclosures. Insulation systems made of Silastic are self-protecting, permit open enclosures outdoors where weather-protected frames would otherwise be required. There's no need for a premium priced enclosure to protect the insulation.

What's more, Silastic's extra thermal capacity provides motors, transformers, and other equipment with additional service factor for absorbing overloads. These motors — with a generous service factor *built-in* — add immeasurably to reliable service . . . operate more economically.

SPECIFY Dow Corning Silicones and **SAVE!**

first in silicones

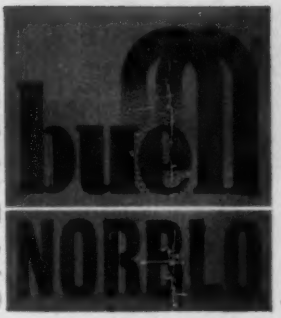
Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

For more facts circle 227 on Reader Service card, p 109

BUELL-NORBLO
TWO GREAT NAMES
ONE GREAT LINE
OF DUST RECOVERY EQUIPMENT

With the acquisition of The Northern Blower Company, Buell can provide a broad range of products and systems for handling every industrial dust and air pollution problem. Norblo bag type collectors now augment Buell Cyclones and other mechanical collectors, electric precipitators, combination systems and centrifugal and gravitational dust classifying systems. And like Buell, Norblo has been accepted and proved through years of experience in active, on-the-job service. Thus Buell is better able to meet both standard and special requirements in fields that include the electric utilities, steel, oil, cement, chemical, paper, and other process industries. Buell Engineering Company, Inc., 123 William Street, New York 38, New York. Northern Blower Division, 6404 Barberton Avenue, Cleveland, Ohio. (Subsidiary: Ambuco Limited, 2-5 Old Bond Street, London, England)



For more facts circle 228 on Reader Service card, p 109

Circle 229 on Reader Service card for following ad ➤

ELLIOTT TURBINES
since nineteen hundred four
MOTORS
since eighteen hundred eighty eight

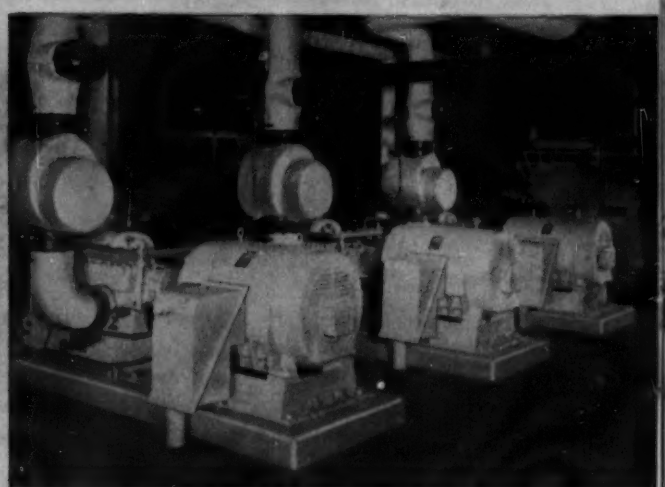
for your auxiliary drives...

Steam or Electric
Large or Small
Indoor or Outdoor

This Elliott geared turbine drives the induced-draft fan serving the 120,000-lb-per-hr boiler for a northeastern pulp mill. Elliott turbines are noted for simplicity, flexibility and year-in and year-out dependability.

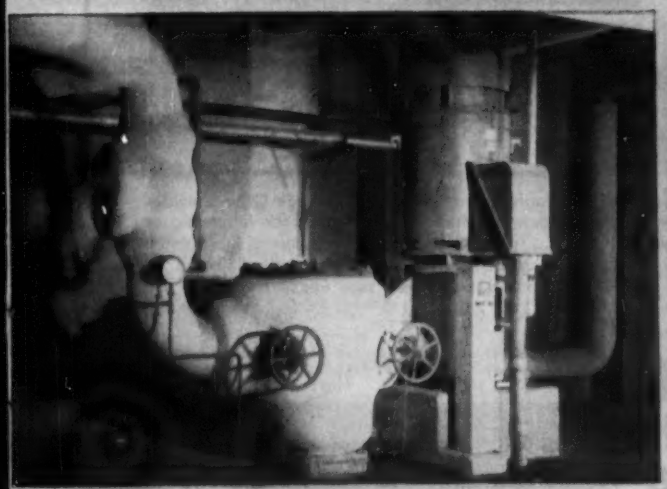
ELLIOTT Company
JEANNETTE, PENNSYLVANIA

Biggest boiler-feed pump motors in the country—each rated 5000 hp at 3600 rpm. Quick-access openings visible on near end of motor; removable swing-down filter panels on each side. Elliott "Super-Quiet" enclosures. 6000-hp Elliott motors will soon be operating.

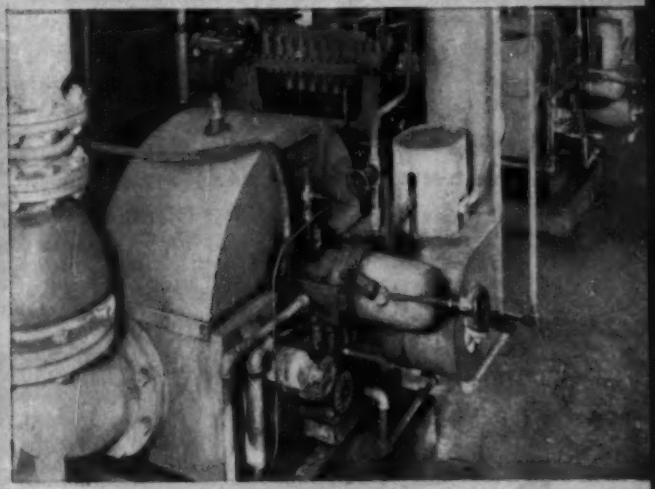


Heater drain pumps are driven by identical 200-hp, 3600-rpm Elliott motors. Elliott water strainers are mounted in pump inlets. Other Elliott products for power plants include condensers, ejectors, deaerating heaters, tube cleaners and expanders.

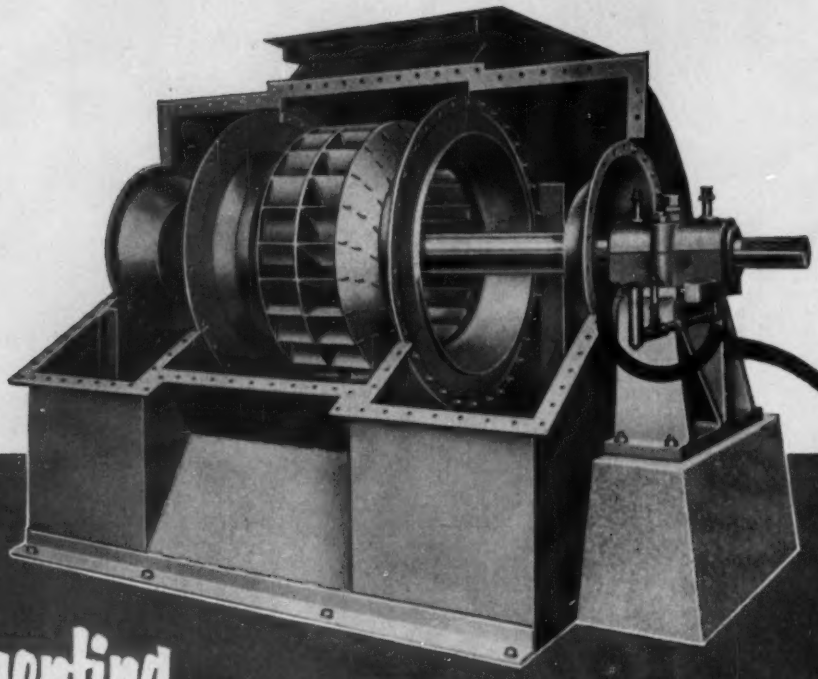
Dripproof 600-hp, 900-rpm Elliott motors driving line of coal pulverizers. Elliott FABRI-STEEL construction assures structural rigidity; FABRI-SEAL insulation assures maximum service life.



Here an Elliott 250-hp vertical, dripproof motor is shown driving a condensate pump. An Elliott twin basket water strainer which protects the pump can be seen at the left. Elliott C-W motor experience dates from 1888.



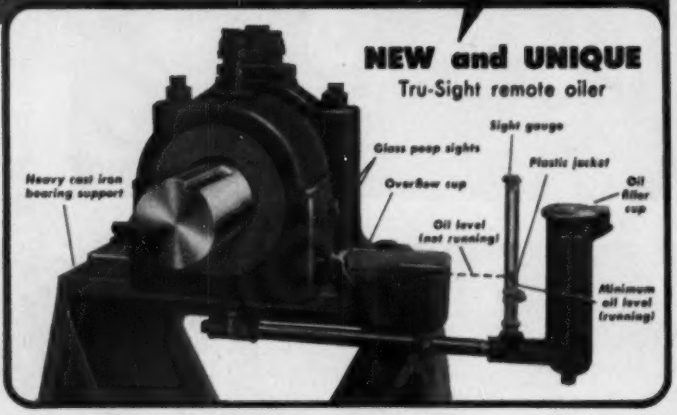
250-hp, 3550-rpm Elliott turbines drive boiler feeders in this industrial plant. All major auxiliaries in this station are Elliott turbine-driven. For over a half century, Elliott has been building turbines and turbine-generators.



Presenting... Another of the features distinguishing CLARAGE MECHANICAL DRAFT FANS

You get more than extra-heavy construction, extra-long service life from a Clarage Fan. You now get a vastly superior oiling arrangement for the bearings—as shown on the right.

Learn more about the many features that make Clarage Fans stand-out performers in forced and induced draft service. Write us today for catalogs or contact nearest Clarage sales engineering office. CLARAGE FAN COMPANY, Kalamazoo, Mich.



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LOUIS N ROWLEY, EDITOR • MARCH 1960 • ESTABLISHED 1882 **Power**

Opportunities in engineering

Is your son considering an engineering career? Do the sons of friends and associates turn to you, as an engineer, for advice on the opportunities in this field? You will be much better informed on one aspect—the supply of engineering graduates and the demand for them—if you read the latest report* from the Engineering Manpower Commission of Engineers Joint Council.

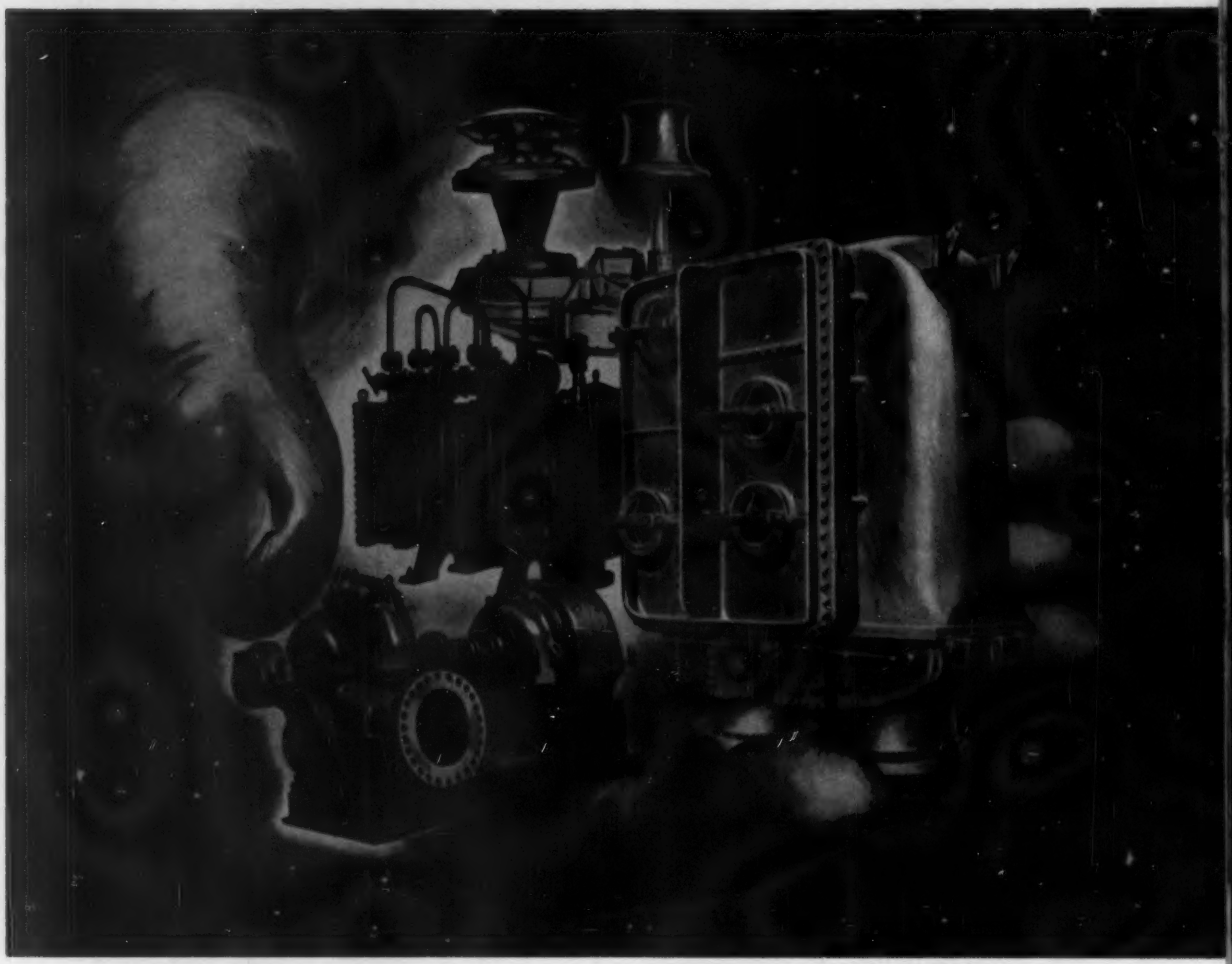
Back in 1958 there was a close supply-demand balance in engineering employment. Industrial recruiting and overall demand for engineers increased materially in 1959 but there was no acute numerical shortage because the engineering graduating class of that year was the largest since 1951—38,162 BS degrees were granted.

Moving into the '60's, however, we face a continued rise in demand for engineers and *smaller* graduating classes. It is estimated, for example, that in 1963, 12 engineers will be sought for every 10 recruited in 1959. And in 1966, 15 engineers will be sought for every 10 recruited in 1959.

With this rising demand, it is paradoxical that fewer young men are entering the engineering field—and yet that is the case. Freshman engineering enrollment dropped off 11% in 1958. In 1959 enrollment was 3% lower than in 1958. Even if this downward trend is quickly halted and reversed, the number of engineering graduates in the early 1960 classes clearly will be less than the demand. This condition might well extend all the way through the '60's unless there are unexpected and drastic reversals in either supply or demand.

No one would, in good conscience, recommend choosing an engineering career merely because men with this training are going to be in great demand. But when we find a young man with a genuine interest in technology and aptitudes that indicate reasonable prospects for success, we can safely urge him to go ahead. When he has developed his talents there will surely be no dearth of opportunities to apply them in rewarding fashion.

*"Engineering Manpower and the National Interest". Copies available on request to Engineering Manpower Commission, 29 W 39th St, New York 18, N. Y.



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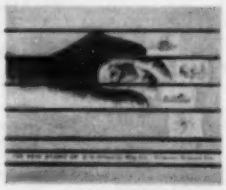

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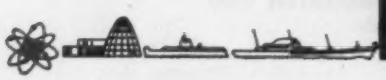

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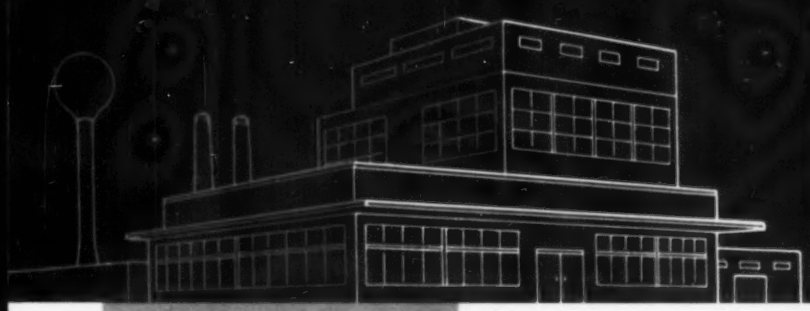
Conditioned Air for Industry



By L E STEWART, *Associate Editor*

More industrial plants are finding air conditioning pays, whether as conditioning for process or the more-recent application to worker comfort. New plants which *must* have clean air of constant temperature and humidity, for precision manufacturing and test, form an ever-expanding segment of industry. Conditioned air can justly take credit for better products, better production, better worker morale. And quite naturally, manufacturers and consultants in this multi-billion-dollar market are taking a hard look at present practice while searching for better techniques and equipment.

If your plant is considering air conditioning, now is the time to think through your real needs and how to go about satisfying those needs. The next 15 pages of this report will be of practical help to you during the planning stage. They outline the importance of clearly understanding the many parts of the problem, then assembling your individual decisions into an overall workable design.

Throughout the report we consider air conditioning in the most general sense of controlled temperature, humidity and air cleanliness—all from the viewpoint of problems unique to industrial plants. To help organize your planning into logical steps, all data is presented in the form of answers to three basic questions.

Now ask yourself these questions:

What do you really need? To help you answer this important first question we point out the problems which must be carefully investigated and solved *before* you make any system selections.....**p 54**

What techniques can you use? Here is a close look at operating principles behind system components and their applications within the general field of industrial air-conditioning problems.....**p 55**

How will you design the system? This final section of the report can guide you in preparing design data, system criteria and equipment specifications for a complete air-conditioning job.....**p 64**

What do you really need?

Most consultants and manufacturers consider the discrepancy between what a client wants and what he needs their biggest single problem. They claim it's this discrepancy that's generally to blame where system performance fails to match owner's expectations. So the first and most important job to tackle when thinking of air conditioning is to sidestep this headache by making a thorough analysis of your plant. And once the analysis is done, make sure it's brought to the attention of the actual system designer and he acts on it.

What to consider in a plant air-conditioning analysis? Total air conditioning involves control of six factors: *temperature, humidity, ventilation, air circulation, air cleanliness* and *sound propagation*. Few factory production areas, and even fewer offices, require total air conditioning. So a realistic analysis of your true needs will probably reduce both the first cost and later operating expense. Include in your study answers to the following questions—they'll help you evaluate properly before setting up any specifications

What are optimum levels for each factor?

For each plant area determine which of six factors in air conditioning listed above must be included, and what degree of control. Then figure optimum condition for each factor. Worker comfort requires temperature control, adequate ventilation and air movement while humidity control generally ties to process needs. On this matter of sound level: a low noise level is often expensive to attain and may cut worker efficiency rather than improve it

What plant loading can be expected?

Equipment sizing and duct layout is based on evaluation of air-conditioning loading for all seasons. Tabulate heating and cooling requirements as Btu per hr to be absorbed or added in each plant area: consider human heat load, heat generated by plant lighting and process, loss through windows, walls, doors plus structural leakage. For humidity control estimate moisture added or removed by process. For air cleaning, state dust and pollutant type including data on concentration and particle size; take test samples where possible

How closely must in-plant atmosphere be controlled?

Having established factors requiring control, and optimum values for each factor, determine maximum deviations that can be handled without affecting plant efficiency, operation or safety. This single step pins down a sizeable portion of system cost; needlessly tight specs simply add to this cost

Can plant afford a temporary disturbance?

Sudden surges in air-conditioning load bite into system reserve capacity. It seldom pays to design using surge peaks as the maximum continuous load. Figure on system capacity being exceeded occasionally for short periods. Where industrial air conditioning requires rigid control to prevent ruined product, plan on standby booster equipment to operate during system surges. To keep standby-unit costs down, hold to maximum permissible deviation

What degree of flexibility is necessary?

A flexible system is a more-complex system. If building is new and manufacturing processes change periodically, ability to handle new and changing air-conditioning loads, merely by control adjustment, can mean savings in the long run. On the other hand, minimum-cost industrial buildings with reasonably stable production capacity seldom can justify a complex though flexible scheme. However, don't overlook projected load changes in your design data

What techniques can you use?

With plant air-conditioning needs clearly established, get an up-to-date working knowledge of the necessary major equipment. The following nine pages will give you just that by covering operating principles for air-conditioning components.

Temperature and humidity control are the basic building blocks of all air-conditioning systems. For a moment consider the two functions together since the control of one affects the other. This interaction is shown on psychrometric chart, right. A complete rundown of air properties and a description of psychrometric processes appeared in POWER's special report, *Air Conditioning*, published in April 1950. Here are vital facts:

Air temperature and humidity are related through the basic properties of steam. For any given air-water temperature, each cu ft of air can hold a specific weight of water vapor: this is the *saturation-temperature dew point*. When air temperature is above this saturation temperature, water vapor is superheated, making the air capable of holding a greater weight of water. This degree of water saturation is charted as percent humidity or percent relative humidity. Remember relative humidity is measured by comparing the dry-bulb temperature (actual ambient air) and wet-bulb temperature (a function of air's moisture content). Juggling air temperature and dew point gives us basic temperature-humidity control.

To see how this basic control works, study three typical processes, each plotted as a line on the chart.

Heating or cooling, without moisture change, follows line *A*. Dry-bulb temperature may increase or decrease but dew point and moisture content remain constant. Relative humidity varies as water vapor becomes more or less superheated. If coil heat exchangers are used for either heating or cooling, result will be a psychrometric plot like *A* so long as coil is above air dew point.

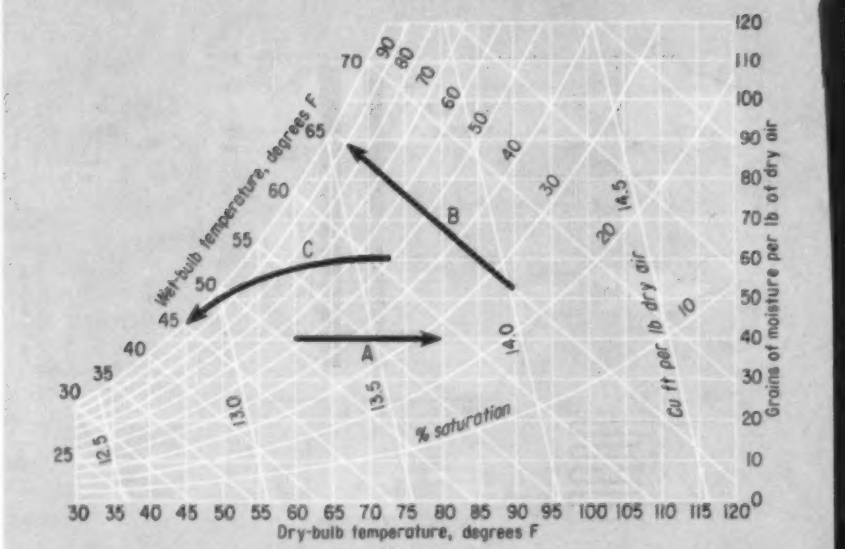
Cooling and humidification process using spray follows line *B*. Addition of water spray raises dew point while evaporative effect cuts dry-bulb temperature. Since dry-bulb and dew-point temperatures tend to approach spray-water temperature, control of entire process depends upon heating or cooling of spray water. Process line for heating and humidification differs from *B*, although spray still is used for temperature and moisture control. By raising spray water above air's initial dry-bulb temperature, we increase its sensible and latent heat (steam plus dry-air enthalpy).

For cooling and dehumidification, spray water or cooling coils may be used. Spray technique is merely an extension of spray cooling: trick lies in keeping water temperature below air-vapor dew point. Air gives up enough heat to evaporating water to drop air temperature below dew point, and some moisture condenses out. With cooling coils, water is removed when coil temperature is below air's initial dew point. Amount of dehumidification depends on this differential of coil and dew point. Process follows irreversible line *C*.

Control of plant air over a wide temperature and humidity range usually calls for a combination of these techniques. A common type of temperature and humidity control includes coil tempering followed first by spray, then by heater coils to set final temperatures. Psychrometric plot of this setup resembles a Z made up of two constant-dew-point lines, *A*, connected by a constant-wet-bulb line, *B*. Entering air gains or loses sensible heat through the coils without change of dew point. With uncontrolled spray temperature, air is cooled through a constant-wet-bulb line. We come out of washer with air that is nearly saturated and at a dry-bulb temperature lower than desired. Reheating coils then come in, boosting dry-bulb temperature and correcting humidity. For any given set of outside and inside conditions, you can get complete control by simply adjusting the temperature of both coils.

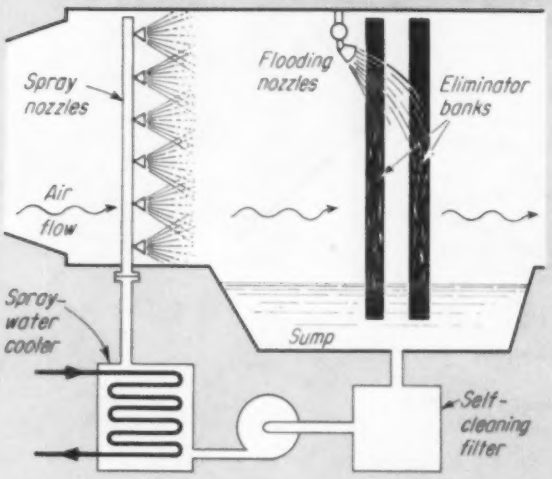
Coil and spray techniques will handle all temperature-control and most humidity-control problems. To see how these techniques apply to actual systems, following pages cover basic equipment for industrial-air-conditioning cycles—the building blocks of complete plant systems.

Air-temperature-humidity relationship

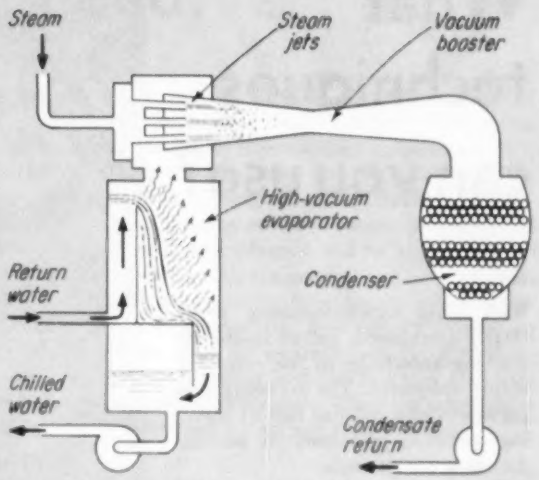


PSYCHROMETRIC CHART lets you plot characteristic lines for any desired process. Lines shown above represent typical coil and spray-system functions

To pick your plant air-cooling cycle, check



SPRAY COOLING is sole direct-cooling method. Operating costs stem from makeup water and temperature control of spray. By itself, spray unit suffers from limited control range. But when coupled with coils, spray units can do triple job of temperature-humidity control and air cleaning. In this case, coils set final relative humidity and meet variations in sensible-to-latent heat ratio. Flooded vanes remove air-entrained water, also tend to trap dusts, some gases and vapors



JET COOLING uses water as refrigerant for coil system. Jet cooling's main advantages are cheap refrigerant, complete safety in event of cycle leaks. Because high vacuum is needed to vaporize water, usual apparatus employs steam-jet ejectors. Since condenser must handle compressed water vapor plus driving steam, cooling-water requirements are high. System finds use where cooling water is plentiful, steam is cheap and refrigerant temperature requirements fairly moderate

Four basic cooling cycles supply most industrial air-cooling needs

With general air-cooling requirements in mind, equipment selection starts by knowing above cycles.

Spray-cooling unit is only system capable of humidifying and scrubbing air while controlling temperature. Cycle diagram, above, includes basic parts of spray unit. High-efficiency atomizers generate a fog bank at the air inlet. For most-effective humidifying action two or more banks of sprays are used. Effectiveness depends upon intimate mixing of air and water vapor, so air velocity through spray chamber usually is kept between 350 and 600 fpm and path of air travel is long.

Spray section is followed by moisture eliminators mounted in banks. These usually consist of wetted plates or scrubbers placed on close centers.

A somewhat different means of securing intimate contact between air and water uses extended wetted surfaces. One application uses spray water distributed by capillary action through glass-fiber mats. Air passing through the thoroughly soaked mass of fibers comes in close contact with water over an extensive path. Result is high-efficiency humidification at expense of higher air resistance. Construction also acts like a viscous filter in cleaning passing air.

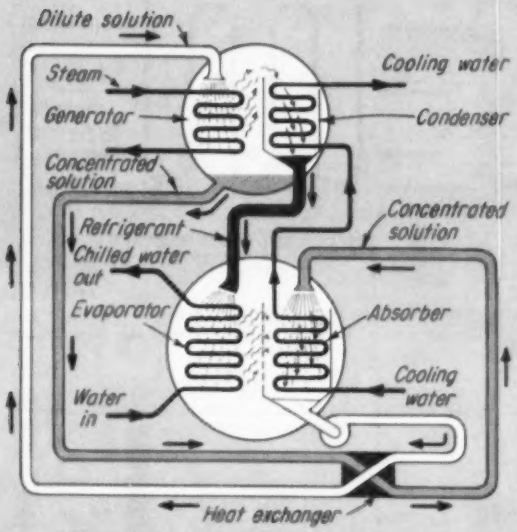
Coil cooling may combine with spray equipment or handle entire cooling-dehumidification job. Where centralized air cooling and extensive ductwork are not practicable, centralized refrigeration equipment can supply coolant to remote coil units. To determine which of the standard refrigeration cycles best fits your needs, compare their characteristics.

Jet-cooling cycle uses a high-vacuum chamber to boil off part of incoming water at low temperature. Since we have no heat input to this part of cycle, latent heat of vaporization, about 1050 Btu per lb in this case, is supplied by robbing sensible heat from the nonvaporized water. Final temperature of chilled water is restricted to 35 F or above by practical limitation on vacuum.

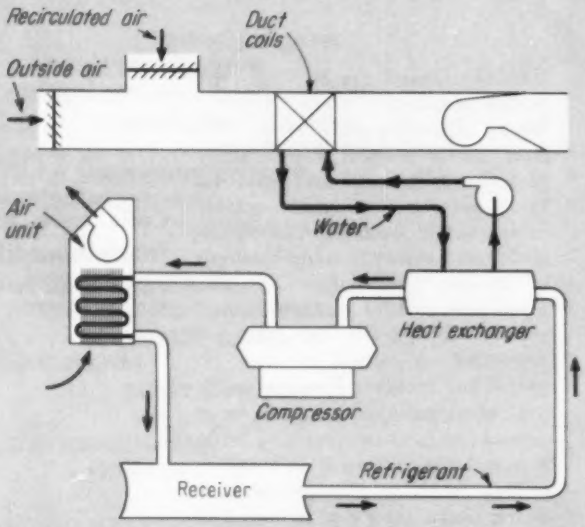
In unit diagram, above, high vacuum is created by steam-jet ejectors which pull vaporized moisture from top of vacuum chamber. Evaporated water and ejector steam exhaust to a normal shell-and-tube condenser. Since condenser must absorb total energy from relatively high-pressure ejector, steam-condenser cooling-water needs are high. In addition, high vacuum means high steam consumption by jet ejectors. These conditions reflect in higher unit operating costs.

Absorption units for modern

operating characteristics, advantages of these systems



ABSORPTION SYSTEM is based on characteristics of liquid sorbents, uses heat for driving force. Since high-level heat source is not necessary, cycle finds special usefulness where l-p steam or waste heat is available. It's an old principle, finding increased application since introduction of lithium-bromide sorbent and construction of large-capacity units. Units require considerable cooling-water flow, show their best relative operating efficiency under full-load conditions



COMPRESSION CYCLE still handles majority of large cooling loads. Mechanical power supplies driving force for cycle. Either electric-motor or turbine-driven compressors couple with expansion cooling in air-cooling coils or through heat exchanger. For centralized systems, secondary coolants of water or brine are safe, cheaper and easier to maintain in sizeable plant. A modified cycle in the form of a heat pump handles seasonal and simultaneous heating and cooling loads

systems incorporate generator and condenser in one shell, evaporator and absorber in another with solution and evaporator pumps mounted below the two shells. Compact packages save on installation costs.

Lithium-bromide salt is used as the sorbent in many units. Here water acts as refrigerant. Boiling point of salt is so high it behaves like a nonvolatile substance. In cycle above there is no vaporization of absorbent in the generator, no carryover of absorbent vapor to condenser.

Heat input to cycle may come in form of low-pressure (5- to 15-psig) steam or other fluids of comparable heat level. This factor opens myriad opportunities for utilization of process steam or waste heat—a unique advantage for industrial plants.

Compression cycle remains our most familiar type of refrigeration for air conditioning. Essential parts of compression system, above, are compressor, condenser, receiver for storing liquid refrigerant, expansion valve and evaporator or expansion coil. Compressors may be reciprocating or centrifugal, electric-motor or turbine driven. For some plants, internal-combustion engines can pay off.

Smaller-capacity units are easily packaged. Larger systems often use combination units for best efficiency over load range: centrifugal compressors, often turbine-driven, handle base load while system load swings are taken by reciprocating equipment. Combined operating efficiency cuts costs for plants with widely fluctuating cooling demands.

Operating cost of compression cycle favors it for plant with high fuel costs. Refrigerants usually can be condensed by water or air at some handy temperature, say 80 F. This allows use of evaporative condensers, straight air-cooled condensers or shell-and-tube water-cooled condensers. Remember, incoming process water may be tapped for free cooling.

Heat pumps are a special brand of compression cycle used for plant's year-'round air-conditioning system. During the cooling cycle, heat pump operates as a straight compression-refrigeration cycle. Whenever heat is needed, functions of condenser and evaporator-heat exchanger are reversed. By rerouting flows, air-cooled condenser becomes evaporator and picks up heat from outside air.

Extracting heat from 0-F outside air requires increased pressure drop in refrigerant. New units often include second compressor in series to boost pressure for heating. Again, centrifugal compressors may handle the base load with reciprocating units supplying second compression stage.

Packaged heat pump cuts installation cost and permits use for spot-cooling operations or waste-heat reclamation. For most plants, heat pumps are economical when electrical rate is low and fuel costs high, or plant needs dictate simultaneous heating and cooling. You can often pump Btu's from one area to another for a reduction in air-conditioning load.

How to control moisture

Humidity control can be vitally important in industrial air conditioning. Where air-conditioning needs stem from worker comfort true humidity control usually is not necessary. But for manufacturing processes, notably in the textile business, precise humidity control may be worth hundreds of thousands of dollars annually. Equipment used for humidity control varies in complexity and operation depending on control precision required and moisture level desired.

Cooling coils can reduce moisture content but can't increase it. Limitation in higher ranges is value of incoming humidity. Sample psychrometric charts show that holding coil temperature below initial-air dew point wrings out some moisture. So aim for a required moisture content at the cooling-coil outlet, then correct temperature with heating coils.

Spray humidity control may take the form of temperature-control units on preceding pages. Remember, varying the spray-water temperature changes final-air dew point.

For processes requiring high humidity, as in textile weaving and finishing, spray equipment offers precise control. Heart of this unit is high-efficiency atomizer: spray nozzles or centrifugal wheels, rotating arms. A main consideration governing selection is space available to complete atomization. To complete job in a small volume, high-pressure nozzles or centrifugal atomizers are used, but you pay for atomizing power.

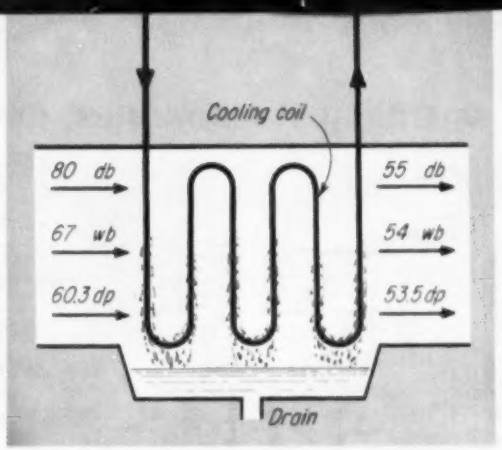
In plant areas where short-time upsets will ruin product, small centrifugal or nozzle atomizers mount in the work area and operate from their own local humidity control.

Low-humidity requirements may fall outside capabilities of either coil or spray systems. For plants requiring very low humidity, chemical sorbents are the answer. Sorbents have ability to extract and hold water vapor from surrounding air. They divide into two classes according to extraction mechanism: *adsorbents* do not change chemically or physically in the process; *absorbents* change chemically, physically or both.

Adsorbents typically are solids—silica gel, activated carbon. They remove water by condensation. To do this they must be dried and cooled. As moisture in air condenses out, adsorbent's temperature rises to point where no additional moisture can enter. At this point adsorbent must be removed from operation, heated to drive off moisture, then cooled. For continuous dehumidification you'll need duplicate adsorbent chambers.

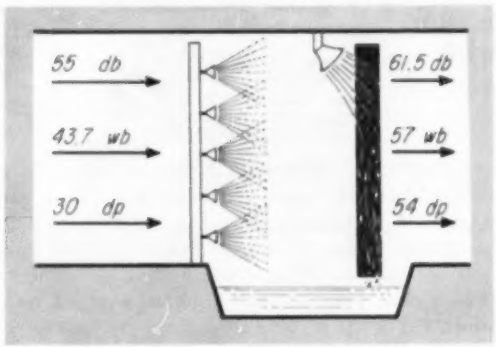
Absorbents typically are liquids—solutions of the halogens (lithium chloride, calcium chloride and lithium bromide) or the glycols. In operation, cycle resembles absorption-refrigeration system. Concentrated absorbent, sprayed over cooling coils, picks up air moisture. Dilute mixture flows to regenerator to be sprayed over the heating coils. Moisture driven off is picked up and exhausted by air. This humidity-control process depends on heat and coolant supply.

Coils cool, heat to dehumidify, can't add water



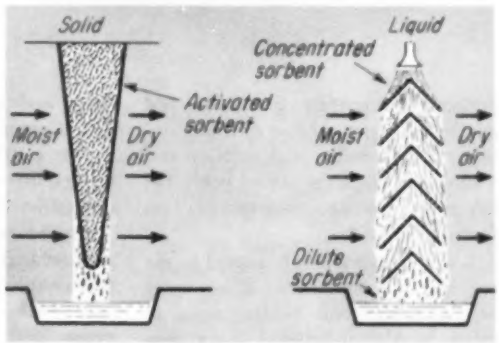
Cooling coils, operating below air's initial dew point, condense moisture. Reheater coils adjust final temperature

Spray controls humidity over wide range



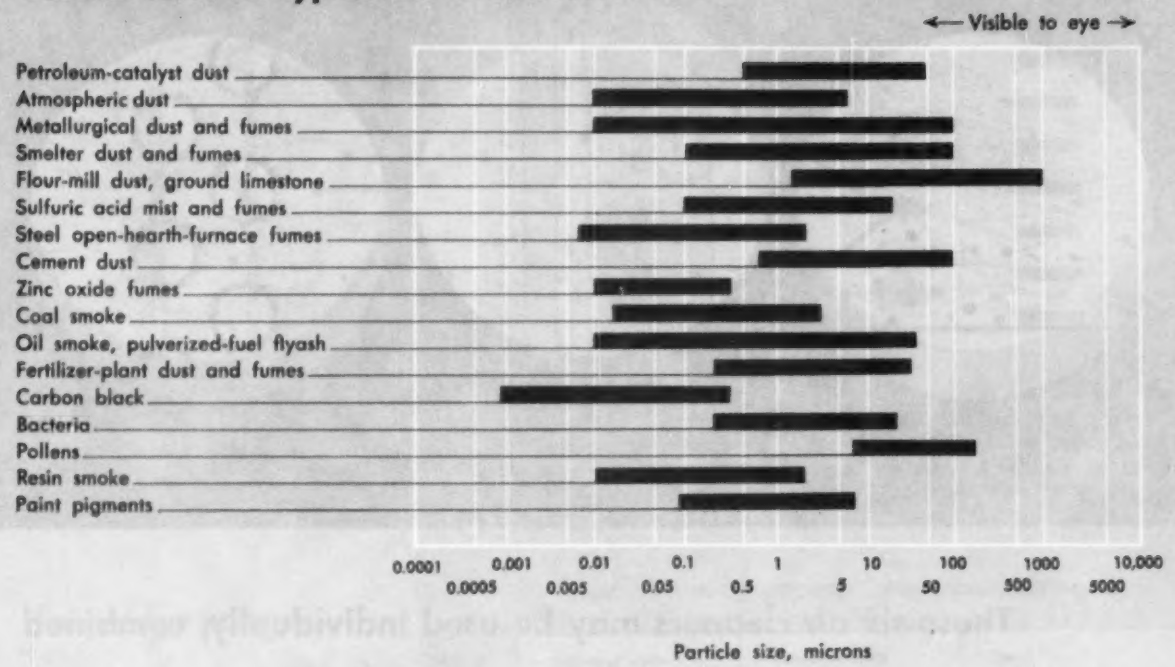
Spray-water temperature controls final moisture content. Good atomization plus scrubbers at outlet cut carryover

Sorbents take up water, fix low humidity



Chemical sorbents extract and hold moisture, create a very low humidity. Saturated sorbent regenerates by heat

Particle sizes for typical air contaminants



Identifying contaminants is first step to clean air

Clean air for industrial plants is one of the most pressing problems facing air-conditioning engineers. Your plant may need clean air for many reasons. Perhaps you must purify process air to prevent product damage or contamination—sterile air for drug-mixing rooms or super-clean air for precision manufacture and assembly rooms in instrument plants. You may have to trap dangerous dusts and fumes—radioactive dust or poisonous gases. A final possibility is air cleaning not for its own sake, but to reclaim valuable material carried as air-borne dust. In each case equipment should be tailored to process requirements.

Air-cleaning equipment groups according to basic characteristics of material to be collected and collection technique. To select best equipment for your plant needs you must know three factors: size range and concentration of particles to be removed, extent of cleanliness required or economically justifiable, reliability and useful life expected of equipment. Consider these factors whether you're picking ventilation- or process-air system to fit your plant's needs.

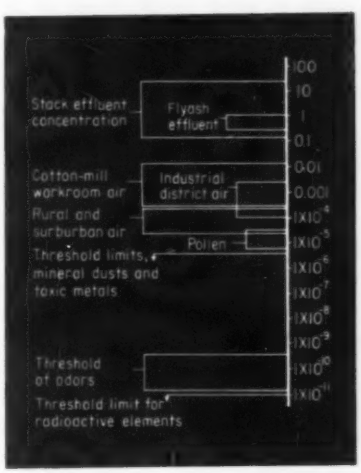
Cleaning plant air is a headache when contaminant is dust produced by your own plant processes added to dust normally found in the atmosphere. Atmospheric dust usually varies from 0.01 to 10 microns. Where atmospheric and process dusts differ radically, two separate air-cleaning systems may be necessary, one to clean up incoming ventilation air while the other handles in-plant air before it recirculates through air-conditioning ducts.

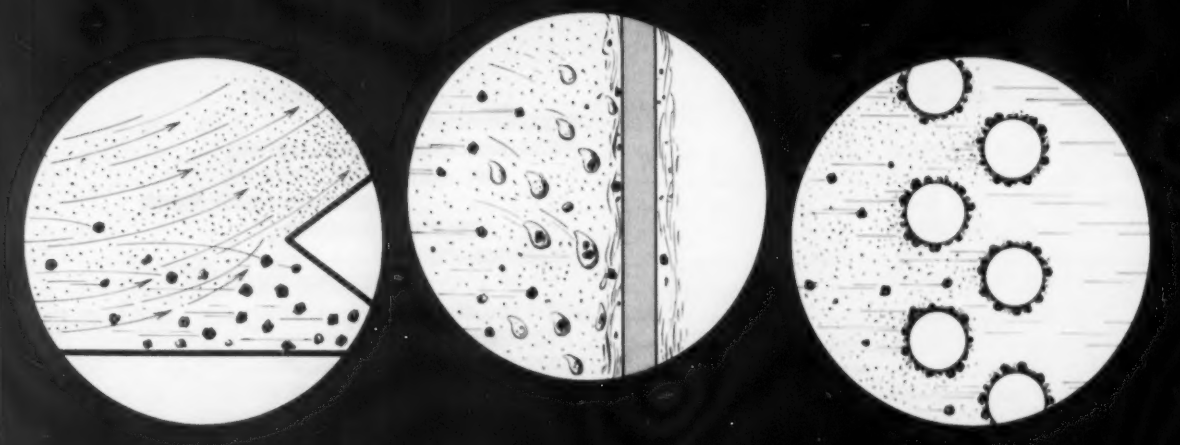
Specifying contaminants can be a big job. Where cleanliness requirements are exacting collect samples of plant air while actual process or an exact duplicate is in operation. If source and makeup of contaminants is known, consultants may be able to satisfactorily estimate particle size and concentration. While manufacturing conditions may vary from time to time, large changes are unlikely and selection of air-cleaning equipment is usually safely based on previous experience.

Particle size of common air-borne contaminants appears at top of page. Figures are rough, but for a specific case a consultant will have a detailed breakdown by contaminant and precise process which created it.

Particle concentration, a function of dust-producing process, also depends on atmospheric conditions for some distance around. Table, above, contains representative con-

Typical dust loadings





MECHANICAL SEPARATION uses particle momentum to collect larger-sized material

AIR WASHER creates scrubbing action as particles are picked up in water film

ADHESION traps particles impinging on coatings applied to collector surface

These six air cleaners may be used individually, combined

centrations over a wide range of conditions. Among other things, values shown help place your problem in perspective—what you thought was a crisis may be normal for your process.

Once your plant's problem is defined in terms of contaminant characteristics and equipment service, you're ready to select specific types of air cleaners for your system.

Six basic techniques, above, cover operation principles of all air-cleaning equipment. But the six basics are somewhat selective in size and concentration of particles they're suited for, so most cleaning systems combine techniques to handle a wider range of cleaning jobs.

Mechanical separation is particularly effective for larger particles, 1 to 100 microns in size, and heavy concentrations of over one grain per cu ft. In equipment of this sort, air velocity is increased and flow forced to make a sharp change in direction. Momentum of the larger particles prevents their turning, so they follow a tangential path out of the main air stream. Since effective operation depends upon high stream velocity and high particle density, collection efficiency varies over the range of air flow to the equipment. In many cases, mechanical separators consist of cyclonic air-flow paths with air exhaust at the cyclone vortex. Centrifugal force throws particles to outside walls where they're collected in a hopper.

Air scrubbing brings back our familiar spray washer. Here accent is on water and entrained-particle separation at surface of wetted plates. Washers are particularly effective with 10-to-100-micron particles and concentrations of 0.001 grains per cu ft and up. Scrubber captures solid particles and entrained moisture when they contact liquid layer; smaller particles swerve, pass through untouched. For lower dust loading, wetted fiber banks do an effective job.

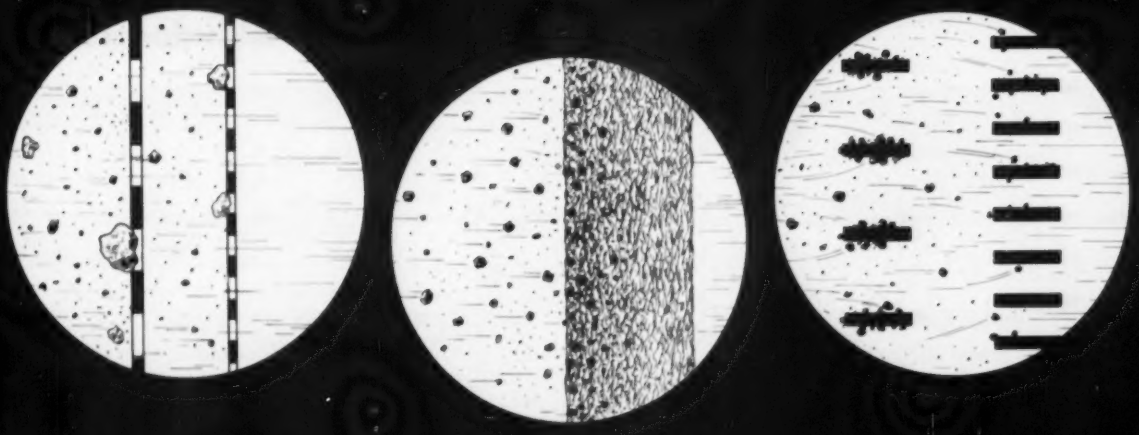
Adhesion plays a part in operation of much cleaning equipment. A "flypaper" barrier of sticky coating is applied to a basic structure of plates, screens or fibers, with prime objects of trapping impinging particles and preventing rebound. Getting particles to impinge on adhesive surface remains function of the base structure —usually one of the other air cleaners.

Particle screening rarely appears as the major cleaning process in unit. An actual screen breaks flow area into openings too small to permit passage of the particle. Basically, one opening is closed off for each particle stopped, so unless screen is made self-cleaning it must plug up in short order. Screening usually accounts for about 10% of cleaning action in other equipment—it's a handy adjunct.

Dust filters handle the vast majority of air-cleaning jobs. Particle sizes from 0.1 to 100 microns and concentrations from 0.0001 to 0.01 grains per cu ft can be extracted effectively by fibrous filters. Filtration occurs in labyrinth air passages around random-oriented fibers when a particle strikes a fiber and sticks. All filters remove particles very much smaller than the smallest pores or openings, so deposition occurs throughout the filter depth. Major filtration is by impaction—when a particle runs into a fiber—and by diffusion.

To understand diffusion we must realize fine dust behaves as a true gas. If a difference in particle concentration exists in one part of air stream, particles from adjacent areas tend to diffuse from higher to lower concentrations. So as fibers trap and remove dust, particles from main stream move to the lower-concentration area at filter fiber, where they're trapped.

Filter efficiency for impaction improves as air velocity increases and filter-fiber diameter decreases. Diffusion is favored by small-diameter fibers and low air velocities and is effective for small particles, 1.0 microns or less, especially those less than 0.1 micron. One last point: filtration efficiency roughly correlates with filter resistance. So specifying higher efficiency than you really need boosts system air resistance.



SCREENING blocks dust flow physically with openings too small to pass particles

FILTRATION traps dust in labyrinth as traveling particles collide with fiber

STATIC ATTRACTION pulls particles to electrostatically charged collectors

for wider ranges

Static attraction performs a function only partially understood in filter operation. Most-important application comes in electrostatic dust collectors. In illustration above statically charged plates attract dust particles of 10 microns or less. For air-cleaning applications, collector plates are often coated with oil to hold particles by adhesion.

Static-collector efficiency depends on particle size, concentration, mass and composition. In addition, air velocity and atmospheric conditions affect performance. High dust loadings usually require high-voltage fields to maintain collection efficiency. Low dust loadings are best handled by 2-stage low-voltage units and relatively low air velocities.

No single type of air-cleaning unit can handle all situations efficiently. Usual systems include two or more cleaners in series. Units best suited to collection of coarse material come first, more-efficient submicron equipment follows. This technique lengthens life of final cleaner.

Chart, right, indicates equipment commonly used for collection of various dust sizes and concentrations. These categories are not rigid since dust-collector selection must consider expected service life, reliability and maintenance costs as well as actual dust characteristics. Your consultant can help you work out the details.

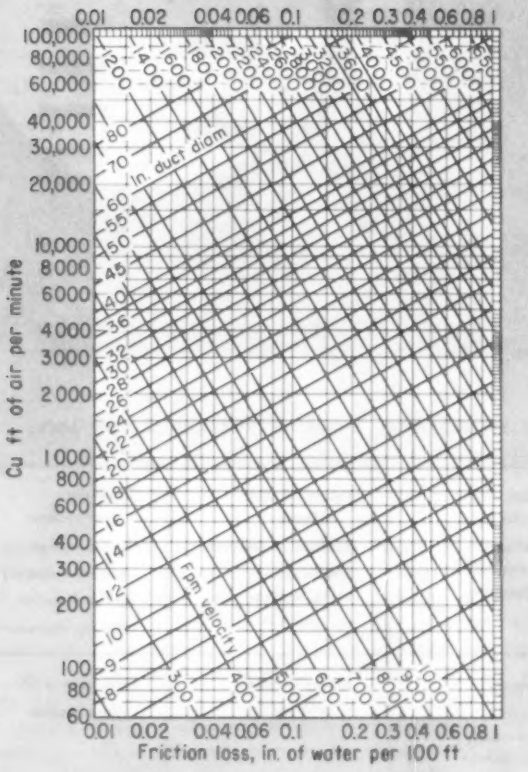
Air-cleaning system recommendations

Dust loading, grains per cu ft	0.1 to 1	1 to 10	10 to 100
10 to 1	Industrial cloth collector High-voltage electrostatic precipitator	Industrial cloth collector Mechanical collector Small-dia multicyclone	Small-dia multicyclone Spray washer Large-dia cyclone Baffle chamber Settling chamber
1 to 0.1	Disintegrator High-voltage electrostatic precipitator Industrial cloth collector	Industrial cloth collector	Wet-fiber washer Spray washer
0.1 to 0.01	Disintegrator High-voltage electrostatic precipitator	High-voltage electrostatic precipitator	Wet-fiber washer Spray washer
0.01 to 0.001	Deep beds of small-dia fibers Low-voltage 2-stage electrostatic precipitator	Deep beds of small-dia fibers Low-voltage 2-stage electrostatic precipitator	Wet-fiber washer Deep beds of large-dia fibers
0.001 to 0.0001	Absolute filters	Deep beds of small-dia fibers	Deep beds of large-dia fibers

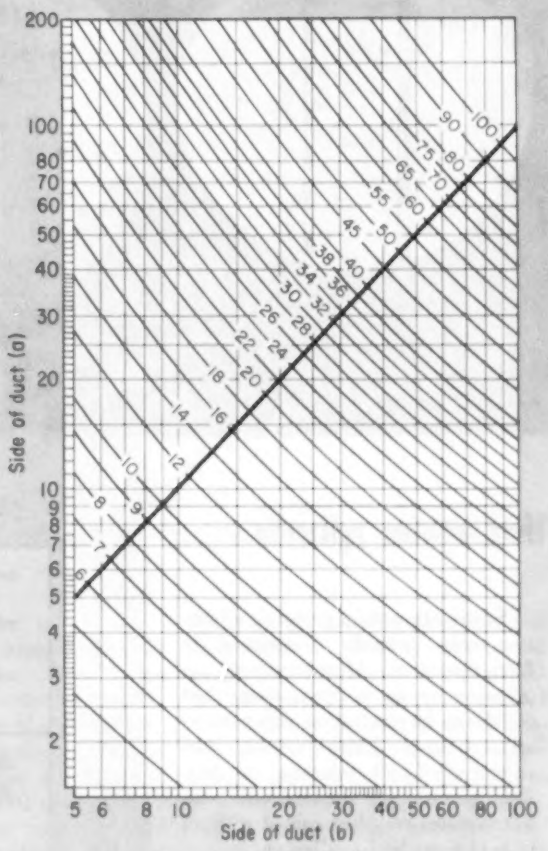
Particle size, microns

EQUIPMENT SELECTION depends on particle size range, dust loading for contaminants to be removed. Recommendations vary with expected service

Air-handling specifications start with decision on



DUCT FRICTION is function of air flow and desired velocity. Values hold for normal air-temperature range



EQUIVALENT-CROSS-SECTION CHART converts round-duct diameter to dimensions of equal-area rectangle

Air-handling equipment takes the cooled, humidified and cleaned air produced by air-conditioning systems and transports, distributes, mixes, ejects and collects it throughout your plant. To scrimp at this point is to jeopardize the effectiveness of your entire system. Let's analyze the different components of a total-air-conditioning system to see how each of these functions is accomplished.

Air ducts must transport air at minimum-resistance pressure drop within prescribed limits of space available for ducts and maximum noise you think is tolerable.

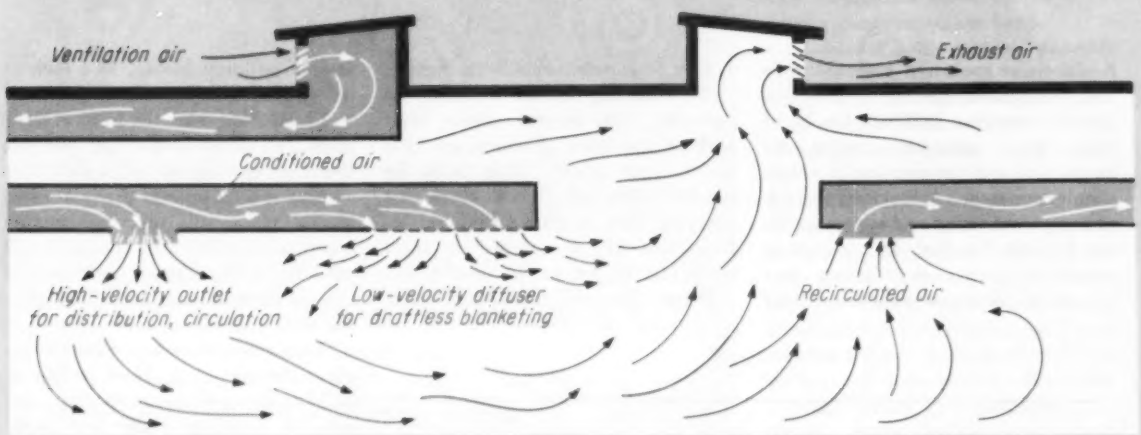
Ductwork imposes flow resistance which first must be overcome by fan energy and secondly balanced out among parallel duct systems to produce even distribution in the plant.

In air-conditioning work, pressure differences usually are small so equations for incompressible flow can be applied. For added simplicity, designers assume air density to be a standard 0.075 lb per cu ft. Chart, above left, supplies friction loss for standard sheet-metal ducts with air at 70 F. Variations in air temperature of ± 20 F do not measurably affect results.

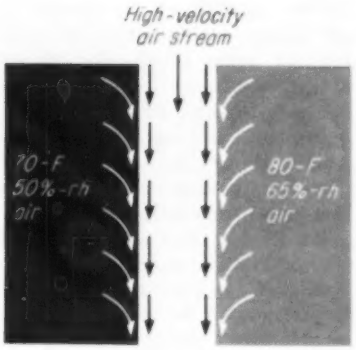
Designer enters chart with known air flow and desired velocity, finds duct size and pressure drop per 100 ft of duct. Figures represent resistance of round duct, but equivalent rectangular duct may be found from another chart, above right. Resistance of duct bends, changes in cross section and fittings are calculated as equivalent lengths of duct. Total resistance-pressure loss of duct, fittings, spray units, filters, etc represents total static head fan must deliver.

Duct sizing may be a problem for office areas with limited headroom and little space for vertical ducts. A quick look at our charts indicates small ducts have very high friction losses, hence high fan-pressure requirements. Where building space is at a premium, high-velocity systems may be warranted, but don't limit duct size any more than absolutely necessary. In economic evaluations for new buildings, balance construc-

high- or low-velocity discharge, duct-design detail



PLANT AIR FLOW includes new ventilation air and recirculating portions. System must handle both. Conditioned air discharges at high velocity for broad distribution. Low-velocity diffusers blanket low-circulation areas with semistatic, draftless air mass



AIR CURTAIN creates isolating wall of high-velocity air to divide plant areas

tion costs of larger building volume needed for larger ducts against first cost of high-velocity system and operating cost of extra fan power.

Air-distributer types vary with their function. Where you want to throw cool air over a great distance, outlets must deliver high-velocity large-mass streams to penetrate room air and carry long distances without dropping to floor level. Except for cases where cold air discharges below the 6-ft level, outlet velocities should be kept above 500 fpm to insure good mixing with room air. Mount horizontal-throw discharge nozzles below ceiling structure, beams and ducts, so that diverging air jet misses all obstructions. For maximum throw, nozzles usually direct air up and out; jet velocity is down to 50 fpm (considered still air) by the time it reaches the 6-ft level. For draftless cooling in areas where circulation rates are low and horizontal throw unnecessary, air diffusers produce hundreds of small, low-velocity streams which act as an air blanket.

Outlet placement must compensate for possible short circuiting of cool air to return or exhaust ducts. Combined illustration, above, includes basic components of air-duct system. For good performance, incoming-ventilation-air, outgoing-exhaust-air, conditioned-air and recirculated-air ducts must be designed and placed to create effective plant air flow.

Special problems arising out of industrial environments add several tricks to normal conditioning practice. Foremost is problem of old industrial buildings with roofs or ceilings 20-plus-ft high. One answer is limited conditioning based on creating horizontal air flow in the plant with basically static air masses above 8 ft. This 8-ft-high air-conditioned space may be 20 to 30 F cooler than upper air. With careful control of air velocities and flow patterns very little mixing occurs. But you'll have to shield hot upper building structure so radiation doesn't cancel cooling.

Air boundaries between different-temperature masses remain relatively intact as long as there's no excessive air movement. You can maintain 10-F differential without any physical barrier. For areas where the motion of people or equipment starts air currents, high-velocity air curtains can prevent mixing of different air masses. As with long-throw air distributors, effectiveness of air curtains depends on creation of high-velocity high-mass air streams. Momentum of an air stream permits it to cut through static air for distances of 10 ft. When applied to industrial cold rooms, air curtains can result in savings in refrigeration load and cut defrosting frequency. Whenever cold-room doors open, dense, cold air pours out and warm, moist room air is pulled in at floor level. If door is opened frequently, warm air becomes a major heat source, and accompanying moisture ices refrigerating coils in short order. But install air curtains in cold-room doorways, set them to operate whenever door is open, and room-air infiltration stops completely.

How will you design the system?

So far we've spoken of general theory and component operation. Now it's time to combine building blocks of temperature, humidity control, air circulation and air cleaning to create a unique system. Actual detailed job of equipment sizing and system build-up is best handled by consulting specialists, but you must have a clear picture of what you want from your system to communicate with them.

Combining hardware into an optimum total system should start with setting down all important facts about your plant. This may be handled efficiently by a check list covering data below. Additional information will be needed in most cases, but this list is a jump-off point.

Before we try combining some sample building blocks, let's look at info included in our check list.

Plant data takes the form of floor plans, elevation drawings, plot-site drawings and any recorded data concerning special process thermal loads. For a plant still on the drawing board, air-conditioning specialist will need rough floor plans, estimates of process thermal loads and all the plot-site data you can give him.

Plant orientation and construction affect thermal load. Heat pickup in building depends on sun shading, surface of building walls and roof, window area and many other items. Shade trees, ground planting and any bodies of water should be accurately spotted for designer's information.

Air-leakage estimates are important factors in your plant-data tabulation. System capacity will be affected by air leakage into or out of the building. In some plants, air leakage around windows, doors and other openings supplies all ventilation requirements. If large air quantities must be brought to a specific area of the plant, placing exhaust-air units here draws from entire building.

But if your plant requires filtered air, infiltration should not supply ventilation. In older plants where air leakage cannot be stopped by reasonable effort, entire work area will have to be placed under positive pressure.

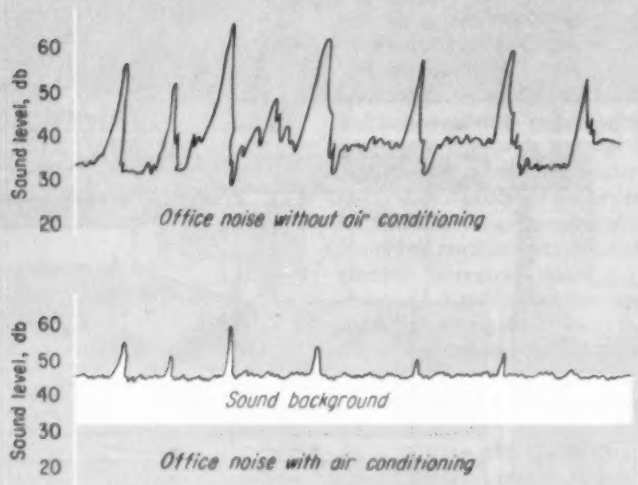
Heat loads due to plant lighting, electric motors, electric heating elements and other equipment may be calculated from reported power input. Office-area and drafting-room lighting level is high enough to create heavy heat loads. When supplying this information, don't forget to state total wattage and type of fixture—type is important since fluorescent lamps generate extra heat in ballast; ventilated or recessed units won't transmit all heat to the conditioned space. For special fixtures, supply complete description of the unit or manufacturer's data on heat output.

Human heat accounts for a large part of total heat load in many plants. Number of workers in a given air-conditioned space should be listed by degree of activity, sex and duration of

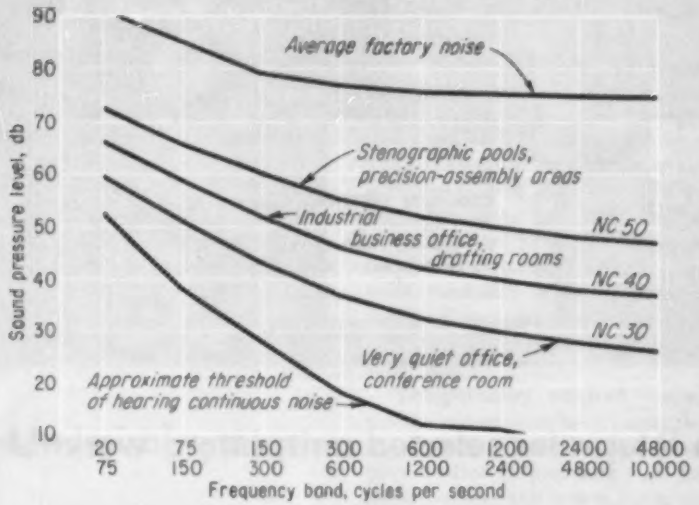
Check list pinpoints design factors

Building location	Supply geographic location and site plans showing orientation of building, location of shaded areas, ponds, rivers, etc
Building construction	Supply plan and elevation view of plant. State type of construction, materials used and exterior color of roof and walls. List material conductivity, reflectivity and permeability for non-standard construction. Report insulation type and thickness for roof, walls, floors and foundation. Don't forget soil conditions. List window areas and type. Note blinds or louvers, degree of direct sun. Include door locations, estimate opening frequency
Ventilation rate	List special process-air needs, number of people in each area and time-occupancy log, also areas where smoking is allowed. Report process contaminants to be exhausted. Estimate air leakage by area
Heat load	Estimate direct process contribution including heated or cooled product in contact with air. List motors, turbines, engines, mechanical drives and driven units. Report lighting location, type and wattage. Include human heat load by workers per area, sex, work description and types of special clothing worn. State temperature design points, control limits, magnitude and period of allowable upset
Humidity limits	State process needs, design points, control limits and allowable upset. Estimate moisture given off or taken up by process
Clean-air needs	List process limits of maximum particle size and concentration, expected contaminants by size range and concentration
Sound levels	State desired inside and outside sound levels for areas by octave bands or noise-criteria curves. Report by octave bands equipment noise which must be reduced or isolated from air system
Energy sources	List power supply, rates, fuels available and cost, usable process waste heat or cold, water supply quality and quantity

Why reasonable noise levels are an asset



SOUND BLANKET, created by air-conditioning system, reduces distraction of periodic loud noises in work areas. Entire system may be tuned to set level



NOISE CRITERIA includes sound-pressure levels for all audible frequencies. Sound curves are keyed to speech interference in 600- to 4800 cps octave band

occupancy—if workers are there only a short time, heat and moisture they bring in may constitute biggest part of total load. In addition to workers' heat contribution, plant temperature, humidity and air-movement values are affected by the same three characteristics of activity, sex and duration of occupancy. You can readily understand that workers doing strenuous manual labor could take lower air temperatures with comfort, but many engineers forget to allow for seasonal acclimatization. Workers dressed normally for winter accept cooler air temperatures, so design point drops about 5 F from value held for summer air conditioning.

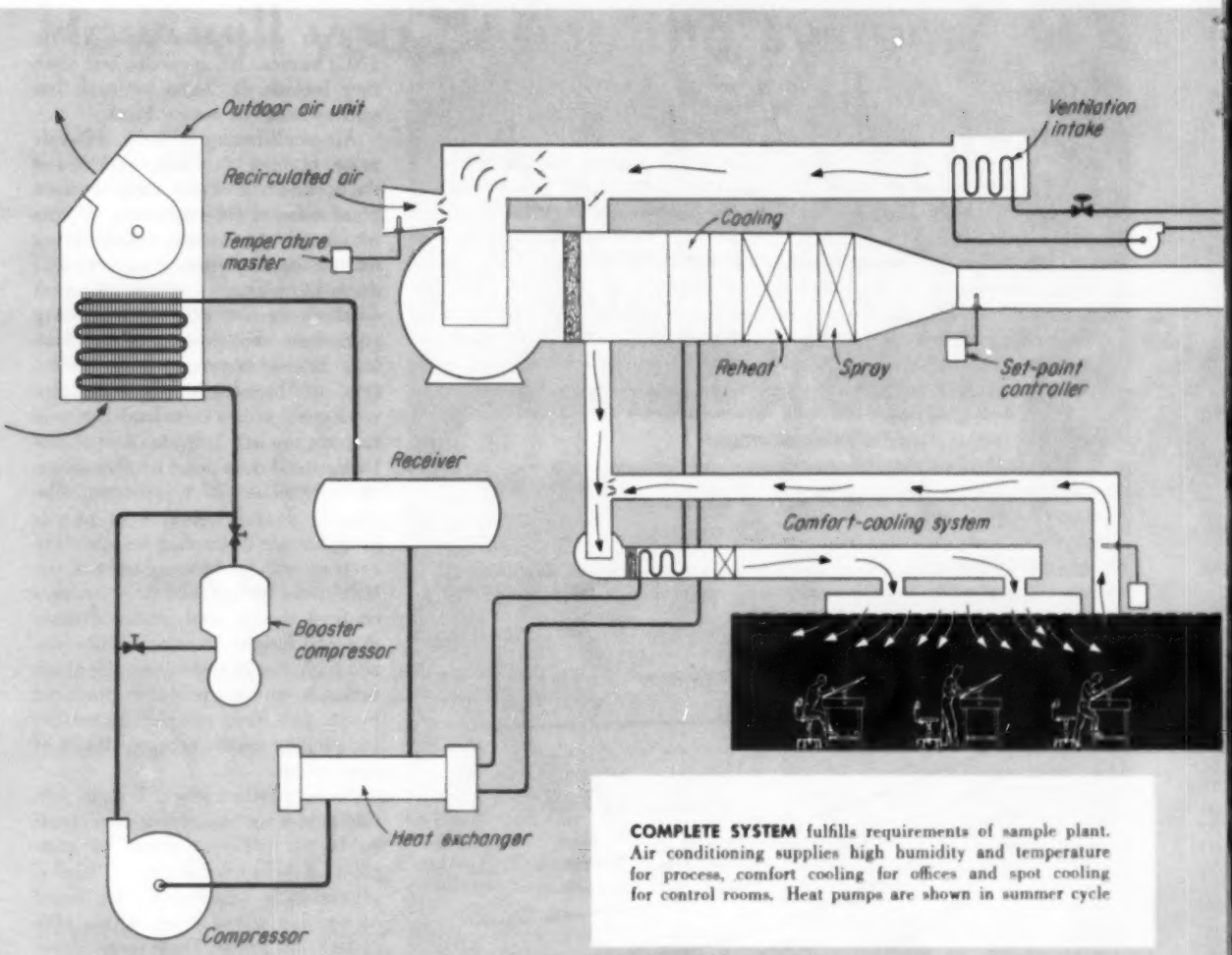
Noise levels in various plant areas are usually specified by overall decibel level or standardized noise-criteria (NC) curves. NC specs are best since they include db limits for each frequency range or octave band.

Air-conditioning systems generate noise in fans, dampers, outlets and ducts, and the ducts may transmit plant noise to different areas. By use of special attenuators, tuned outlets and the natural attenuating action of ducts and plenums you can take most of the noise out of air-conditioning equipment—but this is a mixed blessing. Beyond a certain point, reduction of background noise makes work-space noises seem louder. Sound records, top left, indicate effect of low background noise level in office space. Periodic noises of typewriters, telephones, doors closing, even pencils dropping are distracting because they contrast with background quiet. Carefully tuned background noise reduces contrast sharply and worker distraction and fatigue decrease. When you add high cost of excessive noise attenuation to working problems produced by it, you have compelling reasons for sticking within accepted limits of plant noise.

Noise-criteria curves, bottom left, are guides in specifying acceptable levels for different areas of your plant. Representative curves, labeled according to application, are based on varying sound levels within 600- to 4800-cps range. These three octave bands have the greatest effect on speech interference; average sound pressure for the three is termed speech interference level (SIL).

For factory areas, modified NC curves may be used. These NCA curves duplicate SIL of NC curves but permit higher sound-pressure levels in the lower frequencies. NCA curves are adequate where sound does not fluctuate and ventilating system does not suffer from turbulent flow.

Sound conditioning your plant entails a twofold operation: attenuation of noise generated by air-conditioning system and isolation of process noise from quiet areas. Mechanics of sound attenuation are best left to experts, but here, too you must supply basic design data. Process noise should be reported in db—where possible, report as db levels in each octave band. You must also decide how quiet each plant area should be, and report desired sound levels to your consultant.



COMPLETE SYSTEM fulfills requirements of sample plant. Air conditioning supplies high humidity and temperature for process, comfort cooling for offices and spot cooling for control rooms. Heat pumps are shown in summer cycle

Final design integrates selected units into a workable

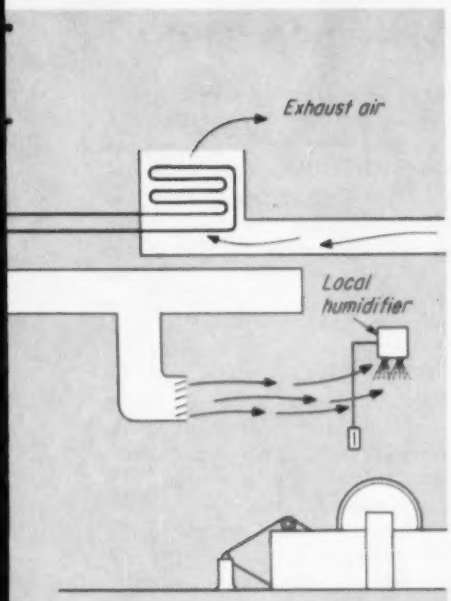
Beyond the point of including or skipping refinements like humidity control and filtration, most increases in system cost arise from requirements for control precision or flexibility. Increases take the form of more-complicated basic units, auxiliary equipment to back up base system and more and more control elements. *On-off* controls are replaced by proportioning and reset units and single sensing elements give way to multiple locations. To keep instrumentation costs within limits, specify precision control only where needed to meet process requirements.

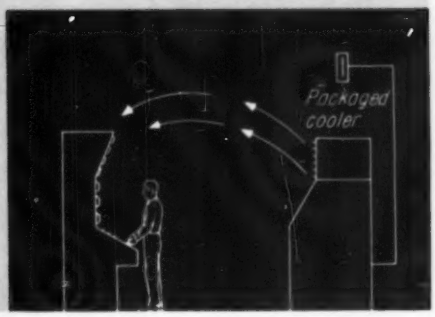
System flexibility can be minimum, medium or optimum. Minimum system handles present plant needs but can't cope with later load increases or changes in location of load. This system features lowest first cost, but quickly eats up savings if later plant changes require modifications. Medium system is designed to handle limited changes in load balance throughout the plant. Optimum system offers best flexibility in rebalancing air conditioning after changing or relocating process heat loads. If plant engineers can foresee several equipment moves or additions coming in the next four or five years, an optimum system should pay off.

Creating air-conditioning systems from specifications calls for know-how plus ingenuity. To see how these traits combine to solve special problems, let's look at a sample air-conditioning system, above. We can analyze designer's selection by taking one building block at a time.

Manufacturing area requires temperature-humidity control to hold 80 ± 4 F dry bulb and 60 ± 2% relative humidity at all times. Office space plus rooms for computer equipment and special process control room form core of the building. Plant, located in North-Central United States, features high electrical load in a low-electrical-rate high-fuel-cost area. Process does not require steam.

Designer's solution, above, em-





economical system

ploys centralized heating-cooling-humidity control system with coils and spray humidifier in series. For office areas, air-duct take-off bypasses central system and supplies comfort cooling. Control room and computer-equipment rooms require uninterrupted cooling throughout the year, so designer used packaged conditioners to spot cool each of these areas.

Heating-cooling requirements and economic evaluation favor heat-pump cycle. System installed includes 2-stage compression for winter operation, outdoor air unit as evaporator-condenser and heating and cooling coils for central system. As an added heat trap, auxiliary heat-pump cycle operates on closed loop between plant exhaust and ventilation intake. Heat transfer in this small loop resulted in 20%-smaller central system.

Control system works as central core with independent auxiliaries. Exhaust-ventilation cycle operates as separate system with built-in reversing function for summer-winter operation. Local packaged coolers include built-in controls and sensing elements. Humidity requirements demand tight control. So central system uses spray unit, with local humidifiers operated by local sensing elements as backup. Local humidifiers mount on building columns throughout manufacturing area with sensing element at machine level. If relative humidity drops to 58% in any area, local spray unit takes over to prevent further drop. Control is simple on-off unit triggered by 58% rh and shut off when reaching 62% rh. Since upset would be short plant owners elected to take the equipment savings and put up with a slight override in each direction.

Need for precision complicates main-system humidity control. Basic system starts with proportional-control space-humidity controller which feeds its signal to the set point of proportional-control dew-point controller. Space humidistat readjusts dew-point controller's set point to compensate for latent heat-load changes. Dew-point controller adjusts outside-air flow and spray-tank water temperature to control dew point leaving spray unit.

Temperature control operates similar master-and-slave proportioning controls. In addition, system supplies control of preheater coil, triggered by coil exit temperature, plus control of exhaust-recirculation-air ratio on basis of outdoor-air temperature. Where humidity control is tight, ventilation-air variations are controlled over a small range.

For plants with lower humidity requirements and tighter temperature control, dual-duct air system is advantageous. In dual-duct air conditioning, heated and cooled air flows through parallel ducts to all points in plant. Area take-offs mix air to control local conditions. Mixing valve operates from local temperature-sensing element, so control responds to small changes and readily handles variations between areas. But dual-duct systems usually hold cold air 25 to 30 F below room temperature so they're overly expensive for humidity levels in the 55%-and-up range. Here cost-efficiency balance calls for a different solution.

Although dual-duct controls cost more their innate flexibility can return added investment if you expect to rearrange, modify, add on or remove processes or equipment. Under these circumstances you can rebalance air-conditioning system through set-point adjustment of local controls, rather than running new ductwork and moving control elements.

System cost for our sample plant would run some 20% higher than cost of the same plant with less-stringent humidity-control requirements. Backup spray units and their controls would be unnecessary; office and plant area would probably feed off the same basic unit.

Office area receives cooled air with variable humidity. Cycle operates as separate system with exception of ventilation and exhaust sections. Cost of dehumidifying recirculated air ruled out main fans for office-air circulation. Acoustic ceiling for air distribution produces diffused low-velocity air. Perforated ceiling includes discharge and return openings requiring special care in duct location to prevent short circuiting of air.

Manufacturing area receives conditioned air through low-velocity ducts ending in long horizontal-throw discharge nozzles. Because factory is new and has relatively low roof, entire space is air conditioned.

Sound conditioning involved removal of some sound, deliberate addition of sound in other areas. Walls of central fan room and refrigeration-equipment room received acoustic treatment. Ventilation inlets include acoustic filters to stop noise emission. Trunk-line ducts of office space have attenuator sections built in and manufacturing-area ducts include noise attenuators in the form of plenums and attenuator outlets. Spot coolers sport special cabinets treated with acoustic lining and sound filters mounted on their free-throw outlets. Basic sound attenuation in office space and one manufacturing area was too effective in high-frequency range, so discharge openings were designed to produce high-frequency sound of sufficient loudness to reproduce NC-40 curve in offices and NCA-70 in factory areas.

How maintenance affects selection and system design

Think about system cleanliness at the same time you tackle other design problems. Plan-ahead maintenance thinking in the design stage should stress access openings for ductwork inspection and periodic cleaning, and provision for water-system treatment.

Duct deposits of oil, dirt, other undesirables build up eventually in systems using high-efficiency air cleaners. Even systems without this degree of filtering collect duct deposits to the point of fire hazard in one or two years. To cut future cost of duct inspection and cleaning, include sufficient access openings in your original design. Consultants or equipment manufacturers can help you lay out locations.

Water treatment for air-conditioning cycle is relatively simple. Combination of proper treatment chemicals and trouble-free automatic treatment methods available can increase equipment life several times.

Corrosion is most common problem of air-conditioning systems. Air washers, cooling towers, evaporative condensers, heat exchangers, piping and pumps are all attacked. Most waters contain oxygen, so they'll corrode metals—and in air-conditioning systems water comes in contact with large volumes of air. In some cases other corrosive gases dissolve in water to form acids. Resulting corrosive atmosphere demands control.

Scale formation occurs where high-hardness water is heated or concentrated by evaporation. Major headaches produced by scale are heat-transfer loss, increased head pressures and clogged spray nozzles and scale deposits on cooling towers.

Air-borne organisms grow into slime and algae. Large air-to-water ratio in washers, evaporative condensers and cooling towers continuously inoculates water with bacteria, fungi, algae. Heavy growths can develop in systems' favorable temperatures.

Chemical control takes the form of slimicides added to water supply plus direct feed of chemicals to areas of extreme buildup. Chemical treatment for scale and corrosion inhibition involves similar equipment.

One final aspect of system design deserves special consideration: How do your plant's maintenance and repair capabilities affect equipment selection? This becomes an important consideration for plant management when evaluating operating cost. Beyond a certain minimum, decisions to include or exclude equipment are based on anticipated operating savings or increased system flexibility. You must carefully estimate maintenance costs to come up with reasonable operating figures. For smaller plants and those not already using types of equipment included in air-conditioning systems, in-plant maintenance may require additional skilled personnel. Illustration shows skills needed for complete maintenance.

Maintenance manpower

Instrument man
handles calibration plus maintenance or repair of controls

Electrician
must service motors, relays, control and power lines to units

Refrigeration mechanic
handles compressors, valves, inspects refrigerant lines for leakage

Pipe fitter
supplies know-how for piping repairs or system changes

For our sample plant, previous page, normal maintenance staff should be able to handle all but major repair work. Highly automated manufacturing operation (evidenced by process control room) would require trained instrument mechanic who could apply his knowledge to air-conditioning controls. Presumably the process operation would take healthy amounts of compressed air to actuate automatic machinery, so mechanics handling air-compressor maintenance could be trained to care for related refrigeration. On this basis, sample plant might not require additional manpower.

Less-fortunate plants must account for cost by one of three methods: (1) assume added manpower cost of plant maintenance crew—an expensive proposition (2) assume cost of calling in outside service for periodic inspection and maintenance (3) assume cost of system service contract.

Basic cost figures for each solution can be obtained from equipment manufacturers or your consultant. Many plants must throw in an added cost in (1) and (2) to cover extended downtime. Where loss of air conditioning affects manufacturing you will have a per-diem premium for getting equipment back in operation. In (1), relative inexperience and possibly lack of specialized tools can slow up repair of major equipment. In (2) the know-how is available, but the hard fact remains that service-contract customers get priority treatment. So you're gambling that priority systems won't tie up available manpower. Although your consultant can be some help in this phase of evaluation, figures still depend on your knowledge of your process.

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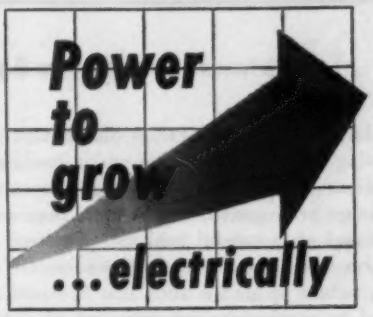
NO. 20: SYSTEM COSTS



WITH GROWTH PLANS for increased production the prime consideration in many industries, better planning of electrical distribution is more important than ever

While digital computers bid for some parts of the industrial electrical-design job using utility-adopted programming, we can't side-step the need for clear analysis of all distribution characteristics as the starting point in planning for growth. Nucleus of a saleable plan lies in knowing . . .

The real costs of a growth system

At a series of two sessions held last month during the AIEE Winter General Meeting, many of industry's top consultants and staff electrical engineers gathered to hear six papers with the general theme of planning-for-growth. These were but six of some 400 papers, but they were of prime interest to those close to the important field of industrial and commercial power-system design.

Digital computers offered some new food for thought as Westinghousemen R F Cook and A D Patton proposed their use in some areas of the overall distribution design. It is well agreed that much of the industrial power-system design in the past followed traditional longhand calculating methods or at best some form of analog computer. But digital computers are used widely in utility-system design, and it was proposed that they be considered for industrial-system design as well.

Starting with the truism that digital programming is expensive to develop but relatively inexpensive to use, the Westinghousemen quickly pointed out that there are available a multitude of computer programs already written for utility-system analysis that can be readily adapted to industrial problems. Programs which might be used are useful in circuit analysis, system optimization.

Circuit-analysis programming includes load flow, which basically is the calculation of power flow and voltages in a mesh type circuit: the short-circuit program, using a symmetrical-component analysis for calculating fault currents, is a mesh system. System-optimization program is suitable for primary-feeder voltage and transformer-secondary studies.

Primary-feeder voltage control program starts with a listing of primary-feeder circuit line impedance, kva-load and pf information on standardized data sheets. Also included are line-voltage requirements, equipment and system costs. Actually, this is the same information required to analyze primary-feeder voltage and design conditions by longhand calculating methods. Information on the data sheets is punched on cards and then may be read onto magnetic tape to improve efficiency of computer use if there are many feeders to be studied. Then the input data either on cards or tape, and the computer program which is on tape, are loaded into the IBM-704 computer where calculations are handled.

In deciding what should be done to a given primary-feeder circuit so that desired voltage regulation is had most economically, the computer program studies the following alternatives: voltage regulators only, fixed capacitors only, fixed capacitors and regulators, fixed and switched capacitors, fixed and switched capacitors and regulators.

One case for a particular feeder would study all the above alternatives with locations of fixed and switched capacitors preselected at a specific location on the feeder. So to determine the most economical solution several cases are run with different fixed and switched capacitor locations specified. Answers, automatically calculated and written onto a magnetic tape for print-out, show equipment locations, ratings, costs for each working alternative. This information includes factors such as equipment installed cost, system investment, I^2R losses. Average computer calculating and print-out time is about 1.5 minutes for each case studied.

Transformer-secondary studies are aimed once again at finding the combination of system components that gives the lowest cost, difficult as this may be. In general it is easier to attack overall lowest-cost problem

One way to figure true cost of reliability

Consider a hypothetical radial distribution system consisting of 1000 ft of cable and a load-centered substation. Supply from local utility is such that no outages are expected to last more than one second, based on a careful analysis of system.

In this case, as outlined by Canadian GE's C M Stairs, nature of load is such that it would not be affected by momentary outages. But an outage of ten minutes or more would mean some $25,000 in damage to equipment plus a 4-day shutdown with an accompanying production loss of $20,000. Any cable or transformer fault would mean an 8-hr power outage. Cable repairs are figured at $100 while a transformer is $500, average experience.

Plant records show average transformer failure rate is one in 250 years while for cables it is 1.3 per 100,000 ft of cable per year. Here's how the true cost of system reliability shapes up based on an investment charge rate of 10%:

Typical load-area cost for an 8-hr outage comes to $45,000. Annual probability of cable failure is 1.3 (1000) ÷ 100,000, equaling 0.013. From the transformer side annual probability of failure is 1 ÷ 250 or 0.004. Assuming a cable or transformer takes 8 hr to repair, annual cable-fault probability cost is (0.013) ($45,000) or $590.

Continuing on this same track, the probable annual cost of transformer failures is (0.004) ($45,500) or $180. Therefore total annual cost of failures is $770, giving an imperfection cost of $7700.

"Consider the cost of imperfections along with that of original

by first separating system into several parts. In this way a manageable portion of the system can be studied, temporarily disregarding the system as a whole. Then subsystem is recombined to find overall lowest-cost system.

As pointed out by Cook and Patton, an important subsystem in power distribution is the distribution-transformer and secondary combination. Here transformer and secondary circuit are studied at the same time since these system components are closely related. Logical approach to the problem of finding lowest-cost means of serving distributed loads at utilization voltage is to select a range of distribution-transformer ratings, secondary-conductor sizes, numbers of connected loads, then try all possible combinations of these variables. Various distribution-transformer-secondary combinations may be compared on the basis of capitalized cost, where capitalized cost of a combination is the sum of (1) distribution-transformer installed cost (2) secondary-circuit installed cost (3) capitalized cost of losses in transformer and secondary circuit of distribution system.

Three design limits influence choice for the lowest-cost distribution transformer-secondary combination: (1) maximum-allowable transformer peak load (2) maximum-allowable voltage drop at peak load (3) maximum voltage drop that can be tolerated, starting a motor of a specific rating. Naturally, lowest-cost acceptable transformer-secondary combination is therefore defined as the combination having lowest capitalized cost per connected load and meeting all the design limits.

IBM-704 has a program written allowing lowest-cost transformer-secondary combination to be found for a given set of conditions. Here are the assumptions made: load is balanced 3-phase or single-phase, all connected loads have same maximum demand and pf, loads are equally spaced along the secondary circuit. It's also assumed that transformer is connected to center of secondary line so that an equal number of loads are served in each direction from the transformer. Of course any number of lines may radiate from the transformer, but each must be electrically symmetrical about it.

Computer makes all required performance and cost calculations, tests for compliance with design limits, prints out a complete description of all transformer-secondary combinations meeting the design limits. A complete description of a combination means transformer rating, secondary-conductor size, number of connected loads, transformer peak load in kva and percent of nameplate, transformer and secondary voltage drop to the most-remote point on the secondary at peak load, transformer and secondary inrush drop due to starting a motor of specified rating at the most remote point on the secondary distribution system.

Capitalized cost of the combination is given in several different forms, including total cost, cost in dollars per kva of demand at the distribution transformer, cost in dollars per connected load. Hence the most economical transformer-secondary combination for the given conditions is the one having lowest capitalized cost per connected load. For a given set of conditions, computer running time to find most-economical transformer-secondary combination is about 30 seconds.

However, in the opinion of W H Dickinson of Esso Research & Engineering Co, programs mentioned above both have severe limitations in that neither does a complete job; neither optimizes complete system design.

Although these programs are steps in the right direc-

The planning-for-growth payoff at American Cyanamid

New plants for new products, new processes in existing plants, expansion or modernization of a going plant . . . this, in brief, is the story of the chemical industry over the past decade. And in the considered opinion of American Cyanamid's E C Siddons, the resulting problems in too many cases would have no economical solution unless the system to be extended or updated had been planned with an eye to electrical growth in the future.

The PTG concept can be sold to management if the proposed design is based on a practical economical minimum for now, yet incorporates provision for additions and alterations so load growth can be handled at minimum cost. What is typical of such a design, from the viewpoint of circuitry?

At American Cyanamid, experience shows two basic schemes lend themselves to growth: *primary selective radial* and *primary loop feeders.* In the first arrangement, two feeders are brought to each sub and switched so that load can be placed on either feeder. Second design is simply a series-like hookup where double-fed loop ties into each sub. Normal operation calls for one open spot in the loop resulting in two radial feeders. This layout allows for fast isolation of faulty cable sections while plant power is continued by simple switching.

Through a series of detailed case histories, Siddons outlined to his AIEE audience precisely how planning for growth paid off by reducing cost and downtime when load growth became a reality.

equipment when totaling true system costs"

tion, much more effort will be needed to develop computer programs to design the most-economical system.

Whether a computer is used, or more conventional means of calculation, the electrical-systems engineer should consider all possible combinations, selecting that which is really the most economical. According to C M Stairs of Canadian General Electric, the choice between possible alternatives is often made without first making a calculated evaluation of the actual worth of such system characteristics as safety, reliability, etc. Each system characteristic is valuable and a measure of this value, for use in comparative studies, can be in dollars.

Perfect systems are necessary for maximum production. However, when overall economy is considered, it is found that maximum *profit* is tied to a less-perfect, but also less costly, power-distribution system. Obviously, even in the best-planned growth system, there is an optimum balance between initial cost of equipment and degree of perfection of the system. True cost may be considered as the sum of initial cost of the equipment and present worth of all the costs which will be caused by imperfections in the system during its lifetime. Then the most economical system will be the one with the lowest true cost.

Initial cost of equipment making up the system should include all expenses associated with design and installation: engineering and drafting, buildings, building space, foundations, structures, equipment, installation, etc. Add in a fair proportion of the cost of spare equipment which would be used in an emergency.

To simplify calculating the cost of imperfections, analyze system characteristics separate from one another. Important characteristics in every system are *safety, reliability, quality of voltage, operating simplicity, provision for maintenance, provision for growth, equipment life, power availability, electrical losses.*

Some characteristics in the above are always more important than others. So in a preliminary comparison only these need be studied. Before a final choice is made, however, evaluate the cost of every item. Where costs of imperfections come up at different times, get a correct economic relationship between them by using the present-worth technique. When both probability and present worth must be used in the same evaluation, consider the basic period of time one year for simplification.

Following is a brief outline of the ways to calculate costs of imperfections. *Safety* has an infinite cost of imperfection since no engineer has the right to design a system known to be unsafe, regardless of the cost saving. *Reliability,* on the other hand, is more tangible since every system is unreliable to some extent. Present worth of the total cost of all losses occurring during equipment's lifetime must be included. *Quality of voltage* is a factor. Where imperfections in voltage result in direct losses, their value should be calculated. Even annoying light flicker may involve additional equipment to eliminate the undesirable effect.

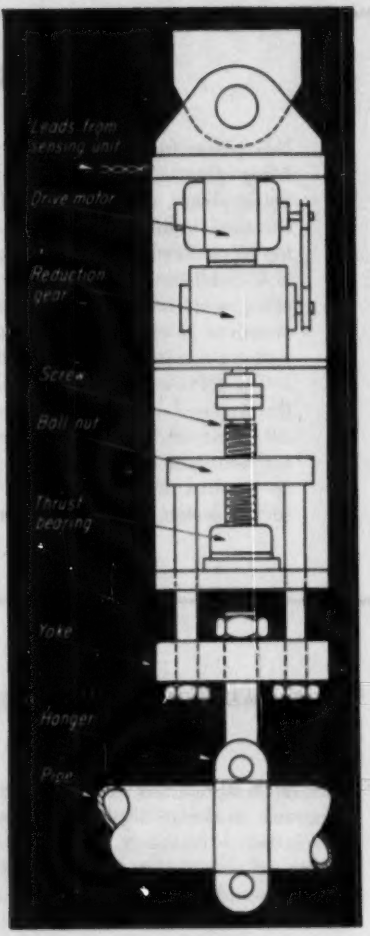
Simplicity of operation is important since cost of imperfection in this area is sum of the cost of providing suitable operators and cost of any losses resulting from the fact that those operators are not perfect. *Maintenance, equipment life, availability of power* and *electrical losses* are all straightforward.

Provision for growth includes an estimate of future growth in capacity and timing. It is often best to spend money for growth initially, to save it in the long run.

New concept for controlling stress aids pipe designers

Positive position control eliminates need for excess pipe to limit end reactions. Support of unlimited load plus unlimited travel capacity simplifies hanger design

By E W CORNER, Grinnell Company, Inc



CONTROL UNIT positions piping in response to signal from a remote point or can give constant support to piping system for unlimited loads and travels

Rising temperatures, increasing pressures and flows add to the complexity of power-plant piping layouts. An adequate piping system must deliver the required flow at reasonable velocities but without excessive pressure drops. Materials used must be stable under all operating pressures and temperatures, and piping size must provide adequate strength under all conditions. Configuration of a piping system must insure that stresses due to thermal changes meet minimum standards for safety and that reactions and moments on connected equipment stay within allowable limits.

In practice, one of these considerations usually controls design and forces over-design from other angles. For example, end reactions and moments on connected equipment may be severely limited by manufacturer. So piping designer has to build flexibility into his system to stay within allowable terminal reactions by adding loops or additional pipe. Then combined operating stresses may be considerably lower than allowable. Not only does additional pipe increase material and erection costs, but resulting increased hydraulic losses may even necessitate larger pipe, further upping costs.

New concept applies controlled external force to positively position piping system, limiting end reactions and moments while utilizing total allowable strength of the pipe.

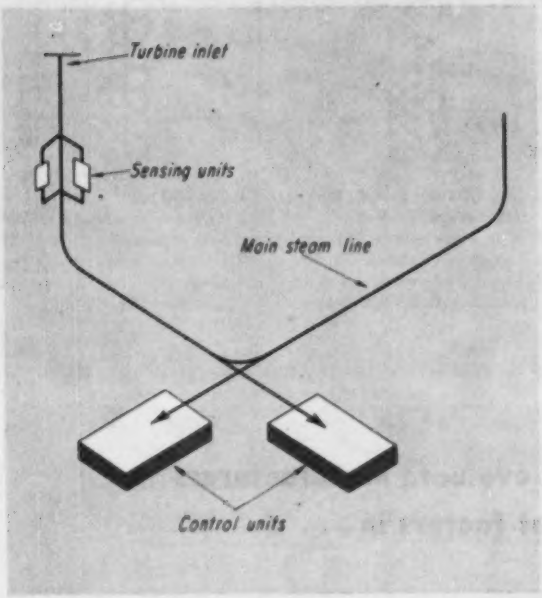
Position control of piping system applies a controlling unit, as shown in the sketch above. Pipe is attached to a ball nut through a yoke and rod. Ball nut moves up and down a screw driven by a small reversing motor through a reducing gear. A scale shows force exerted on the pipe by controlling unit. With minor changes unit can be made to push as well as pull, sc it can move the piping system to a predetermined hot position and assure its return to desired cold position.

Three sensing units are available to operate the control unit. In each case, sensing unit is located at a point remote from but related to the point being controlled.

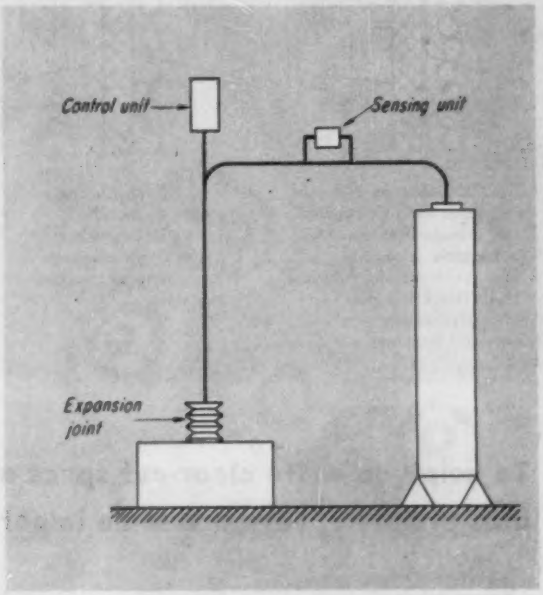
(1) Mechanical position-sensing unit detects movement at its point of connection and actuates switches through a pulley differential system to operate control unit.

(2) Electrical position-sensing unit translates piping-system motion directly into an electrical im-

How to use sensing and control units to position piping system



SENSING DEVICES are located on vertical leg at turbine flange and two control units are located at first horizontal bend. Control units receive a signal from the sensing devices and supply forces necessary to position piping system in accordance with thermal changes at turbine inlet



CONTROL UNIT carries not only weight of pipe but also varying thrust due to pressure changes in expansion joint, since this system is alternately under vacuum and pressure. A spring hanger would have to be over- or under-designed, but control unit can follow varying load conditions closely

pulse to put control unit in operation.

(3) Temperature-actuated sensing unit translates temperature changes in the piping system into electrical signals to operate control unit.

With any one of these three remote position-sensing units, a 0.030-in. displacement actuates the control unit. Accuracy of positioning the point being controlled is ± 0.015 in.

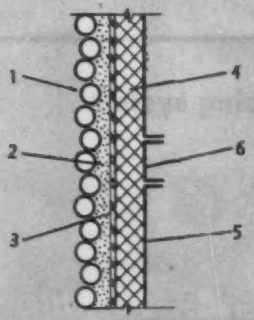
If in addition to positioning the pipe the force applied must be limited, a load-cell cutout can be used to take over control of unit whenever maximum force exceeds a set amount. If desired, a remote indicating and control panel can be installed at a convenient location to test control unit prior to cyclic change in the piping system. This remote panel can also include supervisory alarms to indicate system malfunction. By controlled positioning of pipe or connected equipment during cyclic operation, designer can be sure that stress within the system is exactly what his calculations have predetermined.

The same pressure, temperature and flow factors that complicate design of power-plant piping also increase pipe weight and thermal expansion, magnifying problems of supporting the piping. Designers use constant-support hangers to eliminate additive stress in the piping and limit end reactions on connected equipment due to weight transfer. But constant-support hangers are rated in in.-lb: the load that can be supported at a given total travel multiplied by that total travel. For example, a 16,000 in.-lb hanger will support 8000 lb for a total travel of 2 in. Largest constant support available is rated at 230,000 in.-lb, and this unit is approximately 5-ft long, 3-ft wide and weighs 1800 lb.

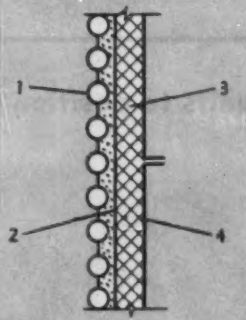
Hanger requirements in modern central power plants can go as high as 2,000,000 in.-lb. To design a single conventional hanger for this capacity would be impractical, to say the least. Therefore, a multiplicity of hangers is currently used to pick up the single load.

Controlling unit combined with a mechanical load cell can act as a constant support for unlimited loads and travels. When you use a single control unit as a constant-support hanger the remote sensing unit isn't needed. Mechanical load cell used instead is made up of two circular-spring steel disks which deflect a slight amount with load. Minute changes in this deflection are amplified, actuate switches to raise or lower hanger synchronously with pipe.

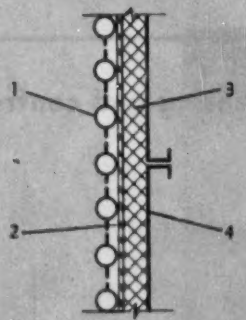
Typical examples of furnace-wall construction



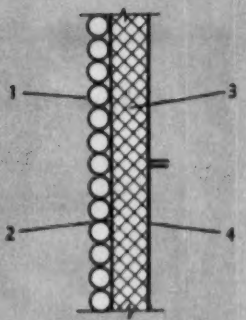
1 2-in.-OD tubes on 2-in. centers, tubes slightly staggered
2 1-in. average thickness of high-temperature refractory
3 ¼-in.-thick asbestos millboard
4 2½-in.-thick insulation
5 10-ga steel casing
6 structural buckstays



1 2-in.-OD tubes in line, every other tube finned
2 ⅜-in.-thick refractory
3 2½-in.-thick insulation
4 steel casing, no structural buckstays



1 2-in.-OD tubes on 4-in. centers, every tube finned
2 ¼-in.-thick asbestos millboard
3 2-in.-thick insulation
4 10-ga steel casing, no structural buckstays, no refractory



1 2-in.-OD tubes in line
2 refractory cement flush with back of tubes
3 3-in.-thick insulation
4 10-ga steel casing, no structural buckstays

To help you write clear-cut specs and evaluate manufacturers' bids properly, here are some important factors in . . .

Basic packaged-watertube-boiler design

By F F HOHNHOLT, Manager, Watertube Div, Superior Combustion Industries, Inc

A boiler purchase isn't impulse buying, the result of a spur-of-the-moment decision. It's a conclusion reached after carefully analyzing all factors involved, writing specifications which the new steam generator must meet and evaluating manufacturers' bids proposing to meet the specs to your satisfaction.

Admitting that the foregoing is axiomatic, it would seem that little more need be said. The catch, however, is that neither specifications writing nor bids evaluation is an easy operation. In many cases written specs do not mean exactly what they say or, in an equal number of cases, say what they mean—or say *enough*. Manufacturers' bids may not be clearly evaluated because of this.

Manufacturer, perhaps slightly befuddled by the specs' inconsistencies, does his level best to come up with a proposed unit which, according to his interpretation of the specs, will fulfill the purchaser's needs. Purchaser, seeing apparent deviation from what he has asked for, may not be in a position to clearly evaluate proposal's intended benefit to him. Consequently he may give a good bid short shrift. Such situations are present in the packaged-watertube-boiler field to a degree which warrants some clarification of spec writing and bid evaluation. To this end, let's take a look at really basic factors in packaged-watertube design.

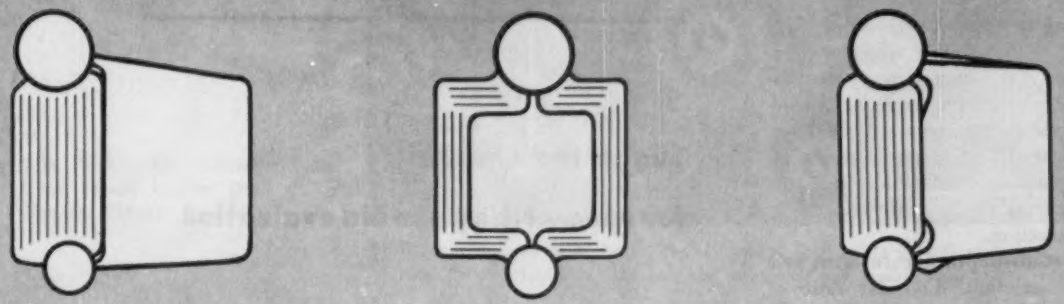
First, a caution: this design is only for fuel-oil or natural-gas fired packaged boilers. It shouldn't be influenced by factors concerning field-erected boilers, brick-set boilers or those designed to burn solid fuels.

Most manufacturers' designs provide a furnace with tangent tube arrangement for sidewalls, roof and floor. Rearwall is water-cooled for at least 40% of its area. There's a minimum of exposed refractory and the furnace is designed to operate under positive pressure.

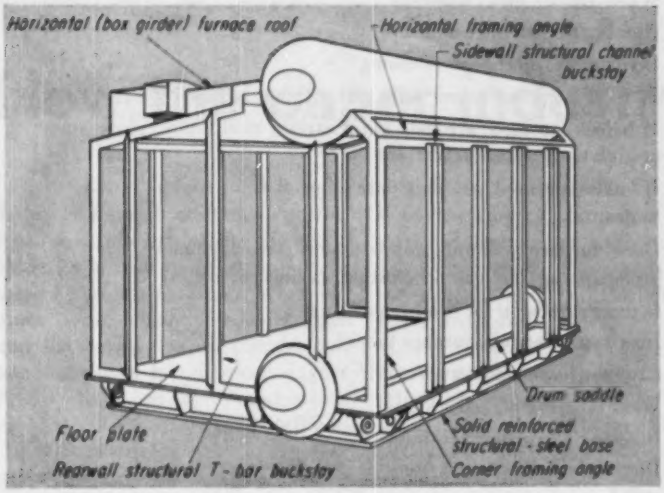
Furnace volume and heat release are *not*, by themselves, important factors. Any calculation involving cubic measurement will produce an answer in terms of volume. *Specific* measurements are the important factors. For instance, a supposedly adequate volume which provides a narrow or shallow furnace is totally inadequate for proper flame propagation without impingement.

Heat release per cu ft furnace volume is only a relative term. We must consider water-cooled and exposed refractory-surface percentages before we can pin down a satisfactory figure. Further, waterwall surface design and quality and quantity of backing material used play a big part in final specifications answer.

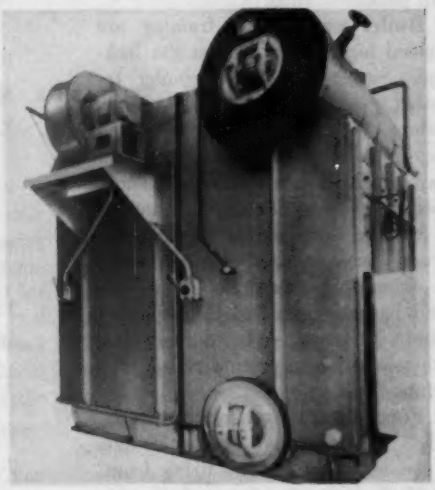
Radiant boiler-surface arrangements used today



These configurations are typical of packaged-watertube-boiler designers' approaches to arranging water-cooled surfaces in the furnace envelope. Some designers use wider furnaces than others, depending upon amount of flame propagation they want. Note, too, that some designs employ more tube bends than others and there are differences in amount of vertical tube length. Other variations are present in the amount of incline given the tubes and the way tubes are spaced to protect the steam drum from excessive exposure to radiant heat



BOILER FRAMING and casing hold the packaged watertube boiler together. Today's designs provide casings requiring minimum service and maintenance



FORCED-DRAFT FANS may be mounted on front or rear wall. Each has advantages and disadvantages

Furnace design should provide proper ratio of black heat-absorbing surface to (1) hold gas temperatures entering boiler tube bank to not more than 2100 F for oil firing and (2) provide enough refraction to sustain combustion over a wide burner operating range. Good design provides waterwalls with maximum vertical length, minimum number of bends and adequate provision for draining all tubes. Recommended furnace width for boiler capacities of 15,000 lb per hr or less is about 5 ft 6 in. center line to center line of side waterwall tubes. Furnace depth must be considered in relation to burner firing rate. In this area, much depends on the firing equipment to be used and whether it is to be furnished by the boiler manufacturer or purchased elsewhere. Important factor is to get properly matched furnace and burner. Good rule of thumb for furnace depth: For capacities beyond 7500 lb per hr, with minimum depth of about 5 ft 6 in., depth should increase by 1 ft per 2000 lb increased capacity up to about 11 ft to allow for flame propagation without any attendant impingement.

Furnace-wall construction in back of waterwalls is another item to consider. Possibility of tube failure always exists, and boiler outages can be costly. So wall construction should be such as to prevent boiler or casing damage if unit must be fired with tubes plugged until a tube-replacement outage can be scheduled.

We're dealing with oil- or gas-fired units designed for forced-draft positive-pressure furnace, so consider protection against gas penetration and casing corrosion. If your specs

call for casings coated inside with mastic material and fiberglass, remember that casing sections must be welded *after* coating is applied. During welding, temperatures will exceed 1000 F. If casing joint design isn't adequate, coating may burn or melt leaving portions of casing without protection.

Heat-absorption rate often gets undue attention. Consider ratio of radiant to convection surfaces. In most designs convection surface, using full tube circumference, will be several times the amount of radiant surface when based on flat projected area. Yet greatest heat-absorption rate per sq ft of surface occurs in furnace. Actually, more convection surface has little value in most standard packaged units.

Boiler casing and framing are welded together to prevent gas leakage. Since they tie the boiler together, they must be structurally strong. Certain plate thicknesses and more welding may cost more, but can pay dividends in a strong, permanent casing needing little maintenance.

Specifications should clearly state drum diameter, number of manholes in drums, whether drum should extend beyond casing or be contained within it, plain or serrated tube holes, provisions for inspecting rolled tube joints, location of nozzles, etc.

Forced-draft fan location is another consideration. Most f-d fans are mounted at boiler's firing front, particularly with conversion type burners. Manufacturers who produce a complete boiler-burner package have a choice and can put the fan at either front or rear of the boiler. Bear in mind that rear-mounted fans may cost more but can have compensating advantages.

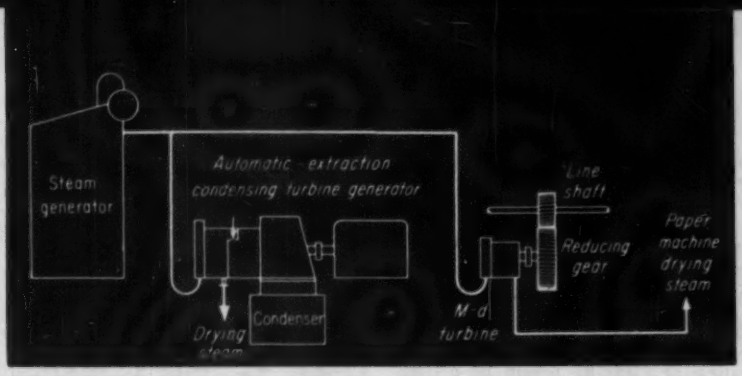
Foregoing is a somewhat limited discussion of some significant factors which should be thoroughly understood by the specifications writer and the person evaluating manufacturers' bids. Clear-cut specifications eliminate misunderstanding between manufacturer and purchaser. Bids based on good specs are easily evaluated by purchaser or his consultant.

As an aid to writing specifications for a packaged watertube boiler, items at right can be used as an important though perhaps incomplete check list. List can be helpful, too, in evaluating proposals.

Suggested check list for spec writing and bid evaluation

1. Maximum designed working pressure
2. Boiler tube-bank surface—full circumference
3. Waterwall surface—flat projected area
4. Tube diameter and wall thickness
5. Tube spacing—furnace sidewalls, roof and floor
6. Furnace width and depth
7. Steam-drum diameter
8. Water (mud) drum diameter
9. Number of manholes in drums
10. Do drums project beyond casing?
11. Is tube bank arranged with or without baffles?
12. If baffles are used, are they plain carbon steel, alloy, or high-temperature refractory tile?
13. If baffles are used, are they parallel or at right angles to drum?
14. Does furnace sidewall construction give adequate protection against gas penetration, casing corrosion?
15. Is there provision for draining all tubes?
16. How many bends in furnace tubes?
17. Are tube holes plain or serrated?
18. What is casing-plate thickness?
19. Is casing adequately reinforced?
20. Does tube-bank casing provide for inspecting tube ends?
21. Number, size and design of observation openings?
22. Is forced-draft fan mounted front or rear?
23. Is firing equipment packaged conversion-burner assembly or f-d register-equipped windbox mounted?
24. When furnished, are soot blowers piped and valved or is piping to be installed at job site?
25. Type and material of water column?
26. Form of ignition for oil firing?
27. Form of ignition for gas firing?
28. Combustion controls: metering or positioning?—electric or pneumatic?—console or free-standing panel?
29. Number and type of scanners?
30. Availability of field engineering service?
31. What are details of performance guarantees?
32. Does manufacturer assume unit responsibility?

By H M PERRY, Mgr—Industrial Sales
Small Steam Turbine Dept
General Electric Company



1 Paper mills need both electric and mechanical-shaft power as well as heat for drying. Proper engineering balances the investment and overall plant steam economy

Practical applications of mechanical-drive turbines demonstrate their wide versatility in serving the power needs of industry. Here we learn . . .

How the paper industry uses turbines

In paper mills, mechanical-drive turbines most often drive the paper machine. Originally steam engines drove these line-shaft machines. When engines were replaced with turbines and the drying system cleaned out, paper makers found much higher heat transfer owing to uncontaminated steam exhausted from turbines.

Turbines drive nearly all types of paper machines from below 100- to over 4000-hp rating. Balancing first cost and steam economy leads to using 5000- to 6000-rpm shaft speed; a precision single-reduction gear drops this to line-shaft speed. Further speed reductions for parts of a paper machine are made by rope drives, belts, differential gearing and even electrically.

Major reason for using turbine drives on paper machines is the precise speed control possible despite continuous variations in load torques. Too often overall plant steam economics get only a passing glance. Usually the steam needed for paper drying exceeds that used by a turbine driving the machine. Excess steam can be used to good advantage if we consider an overall *plant heat balance* rather than just the paper-machine drying needs.

Fig. 1 shows a paper-mill powerplant hookup with one or more turbine-generator units, either automatic-extraction or noncondensing types designed to also supply steam for drying, and m-d turbines for paper machines. Choosing the m-d turbine without regard to overall plant heat balance leads to a single-stage low-efficiency unit. On the other hand, a multistage high-efficiency m-d turbine would use less steam and the steam "saved" can pass through the turbine-generator to produce more low-cost kilowatts.

Another approach works in plants having either a double-automatic-extraction steam turbine or at least two noncondensing turbines serving two pressure levels in the plant. When using steam at the lower pressure for paper drying it may be most economical to use the higher process pressure for the paper-machine turbine and then exhaust this steam to the lower pressure for drying. Low initial steam conditions and high-volume flow allow choosing a multistage high-efficiency turbine. Again the turbine-generator units can generate more low-cost kw. Keeping h-p steam out of the paper plant may produce considerable savings in piping costs.

All factors must be considered carefully. For example, consider two types of turbines, single-stage and multistage, and compare their steam performance over complete speed and load ranges, Fig. 2. Performance of the multistage turbine is better than that of the single-stage unit over the upper load range.

At light loads and part speeds the single-stage unit with fewer fixed losses needs less steam flow. Evaluation of operating time at each speed, initial investment and other factors indicates the proper unit for a particular set of conditions. Each of these turbines has conventional multiple-valve inlet construction since this gives maximum steam economy at part loads and speeds, and also better speed control. All paper-machine-drive turbines rated over 1000 hp and some under this level should have multiple-valve inlets.

Exhaust pressure. To suit different drying temperatures needed by various grades of paper some turbines must run at varying exhaust pressures. Some turbines produce full-rated hp over backpressures varying from 35 to 180 psig, but at considerable sacrifice in potential steam economy.

Fig. 3 shows performance of two turbine designs for driving a pulp dryer. Requirements were 1400 hp at 5000/500 rpm with 130-psig 440-F inlet steam. Exhaust pressure was to vary from 10 to 35 psig. The

solid curves show performance of a multistage turbine to meet these specifications. It was then found that the maximum capability needed when drying at 35 psig was 1170 hp; full rating of 1400 hp would be needed only at 25 psig. Dotted lines show steam savings compared to the larger unit. Properly specifying load-carrying requirements can produce steam savings of 5 to 10%. And if turbine designer knows full requirements, sometimes he can make greater gains.

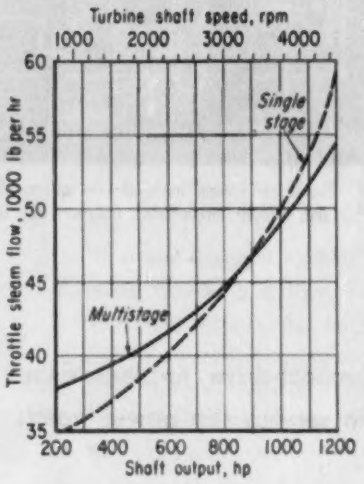
Greater accuracy of speed control can be achieved by limiting turbine size to actual needs, that is, by not "over-specifying" drive requirements.

Governing. Unique ability of a turbine governor to control speed over ranges as great as 6 to 1 has been well established. Machines with ranges of 10 to 1 or more have used various governor arrangements; electric-signal governors and gear-shift devices are available. Latter use conventional hydraulic governing systems, speeding up the centrifugal speed-sensing element through gearing to restore power and sensitivity.

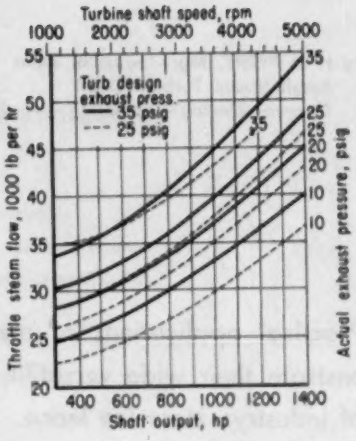
One southern paper mill uses an interesting arrangement to get a wide speed range, see "Trends in power-plant design for modern paper mills" by T J Judge, ASME Power Conference, September 1958. Two turbines and two gear reducers develop 14 to 1 speed range. Steam performance is improved by running the smaller turbine at its optimum speed while driving the paper machine at low speed through two gear reducers in series. Unused turbine disconnects at the coupling.

Another novel setup drives a small specialty paper machine in New England over an 18 to 1 speed range, Fig. 4. Here a single turbine drives the end-of-the-line shaft through two speed-reducing gears in series. First gear reduces from conventional turbine speed to line-shaft speed. Second gear gives operator option of choosing either a 1 to 1 or a 3 to 1 ratio by an external shift lever. With a 6 to 1 range on the turbine speed governor, an overall 18 to 1 range becomes available at reasonable cost using conventional parts.

Combined drives. When one of the many types of electric drives runs the paper machine, a geared turbine



2 Comparison of single- and multistage turbines for 400 psig, 650 F, 150 psig



3 Comparison of two turbines designed for two different exhaust pressures

can work with the main ac motor and supply all of the steam for paper drying. Flow capacity and efficiency of turbine can be selected according to what should be done. Main ac motor may drive dc generator to power sectional dc-motor drives on machine.

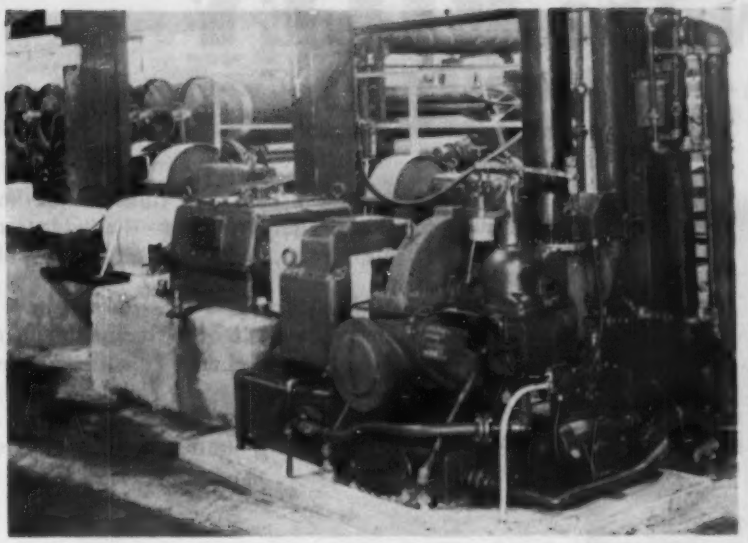
If an oversized high-efficiency turbine drives the motor-generator set the turbine not only furnishes all power needed by the dc generator but will also "pump back" power with the ac motor acting as a generator. With less-favorable steam conditions or a smaller turbine the turbine will aid the ac motor in satisfying both load and steam requirements.

With these turbine-generator arrangements the turbine governor is designed for constant speed and need not be the high-precision variable-speed type needed for direct drive; the ac motor maintains speed control. Perhaps turbine should have a back-pressure governor to maintain pressure at the drying header and a speed-reset device to transfer automatically from backpressure-governor to speed-governor control during electrical power disturbances. Using the turbine for starting: (1) minimizes starting duty of the ac motor and (2) electrical-system disturbances, and also (3) proportionally reduces cost of the motor starter.

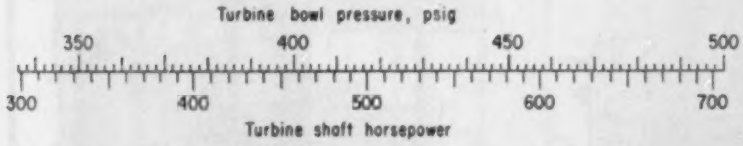
Mill drives. Now let's follow a log from the log pond through the paper mill and see where turbines are the economic prime movers. Economics should be the main reason for choosing turbines, but sometimes peculiar conditions dictate the choice.

In one unusual use, a noncondensing turbine drove a log hoist through usual clutch and gearing. The reason? Turbine exhaust steam in the wintertime was just enough to keep the log pond from freezing! This would not work out in the far north, but here it was the economic choice.

Hydraulic barkers use large quantities of water at high pressures. Here's why turbines are often found to be the most economical drive: (1) A high-speed pump (over 3600 rpm) costs less than a low-speed pump for a given output. (2) Variable speed produces just the right hydraulic pressure, depending on seasonal character of the bark or type of log. As a secondary benefit, considerable water can be saved by running the pump at its optimum speed. Also, upward speed adjustments compensate for normal pump wear. (3) Large 2-pole motors are subject to maintenance and may be difficult to start on small power systems. (4) Turbines can be remotely controlled from the barker position—turbine and pump can be in the powerhouse for better supervision with a single h-p water line running to the barker.



4 This 100-hp turbine drives a paper machine in a New England mill. Turbine speed range of 6 to 1 is extended by two speed-reducing gears to overall 18-to-1 range



5 Adjacent scales correlate turbine-bowl pressure with turbine-shaft horsepower output; these apply to 700-hp turbine with 600-psig 750-F 160-psig 5045-rpm conditions

(5) With barker pump in the powerhouse a standby pump can be used either for boiler feed or the barker.

Chippers. Large slow-speed motors usually drive whole-log chippers, but for some conditions this can be done economically with a turbine gear set. Set's rating must be considered carefully to avoid over-specifying. The turbine's natural ability to produce greater torque at lower speeds can be an advantage in handling maximum-sized logs. Also, stored energy of the chipper and its drive can produce power to chip the larger logs. Normal rating can be more nearly determined by considering the average-sized log.

Overall power balance of the mill plays biggest part in choosing a chipper drive. If new chipper requires new generating capacity or buying peak power from a utility and if surplus boiler capacity is available, a turbine drive could easily prove in.

In one installation the turbine drove a chipper and also an air compressor by a shaft extension off the low-speed gear. Since compressor could be disconnected at operator's option, arrangement permitted quick shutdowns to change chipper knives. Compressor was disconnected when maximum load was needed for chipping.

Refiners. Passing on through the mill we find turbine gear drives for the jordans or refiners. Motors usually drive these units, but turbines prove economical where steam power costs less than electric generation. In most new mills the jordans stand next to the wet end of the paper machine and turbine drives need only short piping runs to connect exhaust into the dryer header. Reduction gears lower turbine-shaft speed to required output speed, but choose both elements carefully to stay within standard gear ratios of 10 to 1—or lower, if possible.

Control. Operators can supervise individual units or groups through remote control and instrumentation. Operators of electrically driven units use a wattmeter to gage the load on individual units and make adjustments accordingly. Loads on turbine drives can be gaged by measuring the first-stage bowl pressure, Fig. 5. For constant inlet and exhaust pressures, bowl pressure at rated speed is proportional to flow and hp output. An accurate steam-pressure gage can be calibrated to read hp output directly.

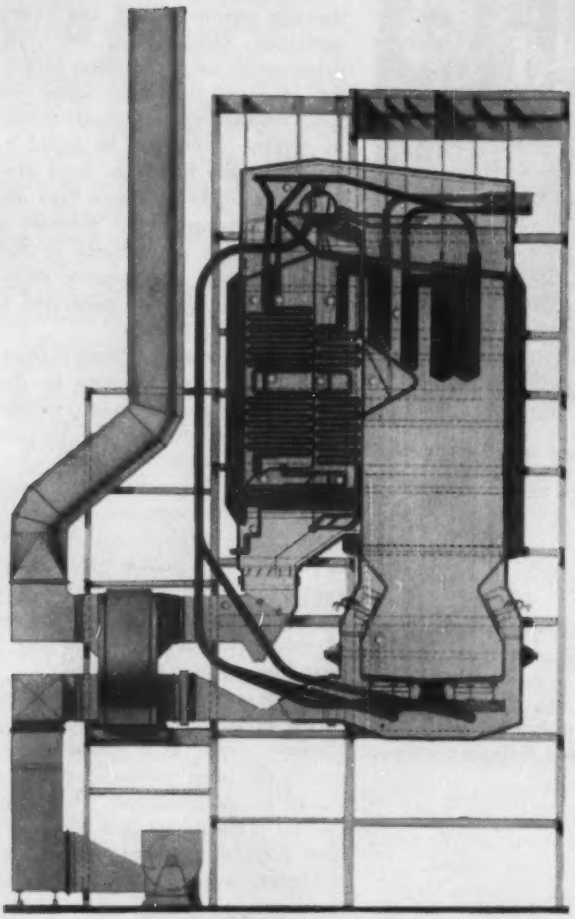
Vacuum pumps. Steam turbines often drive vacuum pumps to economic advantage. Here too, exhaust steam can be absorbed by the machine dryer system through short piping runs. Depending on economics and desired operating flexibility one or more turbines may drive one or more vacuum pumps. Since pumps run at low speed, steam efficiency of high-speed turbines may indicate use of double-reduction gears having a gear ratio greater than 10 to 1.

For several vacuum pumps connected in tandem, consider using a "dummy shaft" as a spacer if any one of the inner pumps must be removed for maintenance. This keeps the rest of the pumps in service. Simplest form of constant-speed governor controls the turbine drive for these pumps. Remote controls and automatic process controls can be applied where needed.

Mechanical-drive steam turbines are used in the paper industry when:

1. High-pressure steam is available and there's a concurrent need for l-p steam for drying, bleaching, digesting or other uses.
2. Precise speed control either at constant speed or over long speed ranges is needed.
3. Mechanical equipment must be driven at any speed, either extremely high or low.
4. Remote control, either automatic or manual, needs to be applied.
5. Loads need quick starting and high starting torques.
6. Ability to operate under extreme ambient conditions, high and low temperatures and dusty and wet atmospheres is needed.
7. Sustained reliability for long periods with minimum maintenance and operator attention is valuable.

How The RILEY TURBO FURNACE



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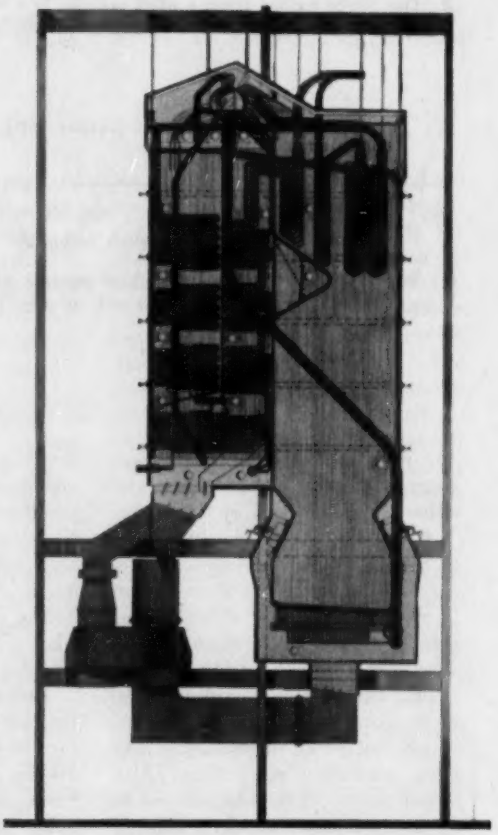

Florida Public Utility — 600,000 lbs/hr
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Delaware Power & Light Company
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Texas Electric Service Company
Monahans, Texas

*Sterlington Steam Electric Station
Louisiana Power & Light Company
Sterlington, Louisiana

Rockwell Station, Unit No. 6
Manila Electric Company
Manila, Philippine Islands

*North Lake Steam Electric Station
Dallas Power & Light Company
Dallas, Texas
Two (2) Boilers

*Turner Unit No. 4
Florida Power Corporation
Enterprise, Florida

*Little Gypsy Steam Electric Station
Louisiana Power & Light Company
Little Gypsy, Louisiana

Agua Fria Station, Unit No. 3
Salt River Power District
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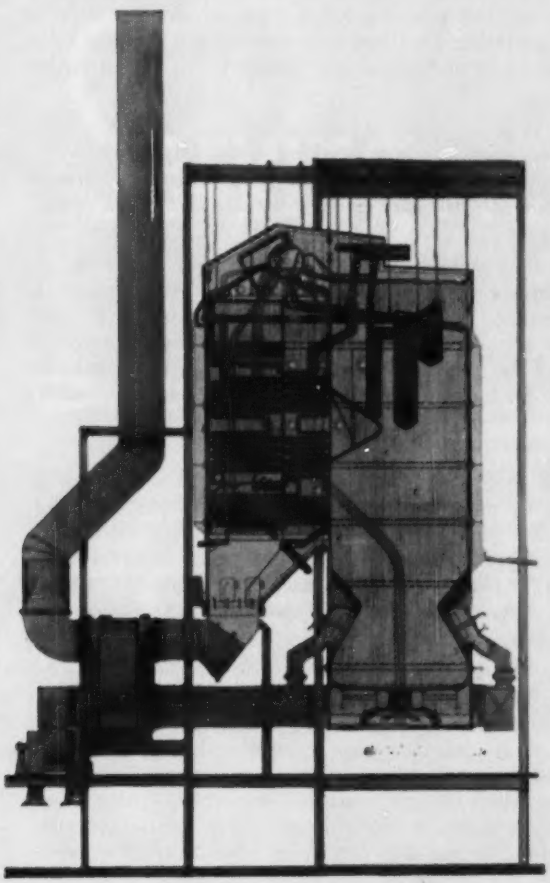

Texas Public Utility — 825,000 lbs/hr
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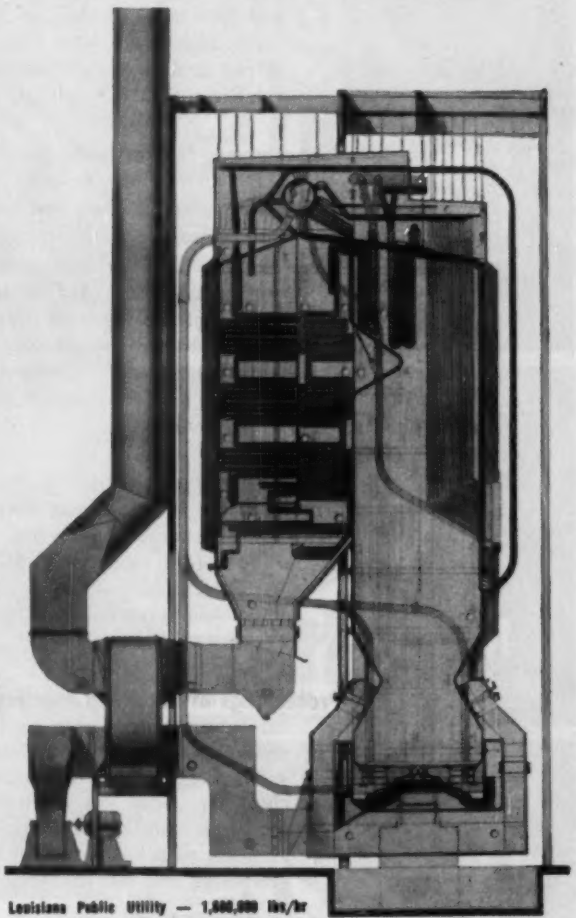

Louisiana Public Utility — 1,600,000 lbs/hr
1005/1005F; 2350 psig — Gas Fired

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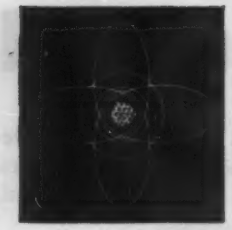

Nuclear notes

By B G A SKROTZKI, Associate Editor

Radioactive wastes will be stored in government-owned lands under long-term government control to assure protection of the public health and safety. The AEC will make detailed studies of the geologic, hydrologic and topographic features of any proposed site. On acceptable sites monitoring procedures will insure that operations are properly conducted. AEC assumes that state governments may establish similar sites in their areas in the future. It may be possible to store all low-level wastes generated between now and 1980 in the 16 states of the northeast U.S. in a 200- to 300-acre site. For the time being high-level wastes from processing irradiated fuel elements will continue to be stored in the specially designed tanks underground at Hanford, Wash. and Savannah River, S. C.

Fast-neutron reactor with 5-mwe capacity has been working since July 1959 in the U.S.S.R. town of Obninsk. The U.S.S.R. intends to build one 50-mwe fast reactor and another 250-mwe fast reactor; no dates are given. (*McGraw-Hill World News*).

More money has been spent on handling atomic wastes than on any other industrial contaminant. Present AEC installations have an investment of about $200 million in equipment for handling, treating and disposing of radioactive wastes. It takes another $6 million annually to run these facilities. The general waste problem need not retard development of the nuclear-energy industry if a bold, imaginative and realistic research and development program is carried out, says AEC's J A Lieberman.

Atomic-energy products shipped in 1958 had a total value of about $148.9 billion in the U.S. Items forming the lion's share were: reactor vessels and tanks, $17.1 billion; reactor fuel elements, $23.9 billion; reactor accessory instrumentation, $15.3 billion; heat exchangers, $13.8 billion; valves, $11.4 billion; radiation survey, monitoring and control devices, $13.8 billion; radiation-counting equipment, $10.4 billion. About two-thirds of this dollar volume was shipped by U.S. Government agencies.

Proceedings of Technical Meetings, 29 pp, is now available free from the AEC Technical Information Service Extension, P O Box E, Oak Ridge, Tennessee. It lists proceedings of 126 meetings held during past ten years together with their availability and price. Nineteen subject areas covered are: accelerators, biology and medicine, chemistry, computers, controlled thermonuclear reactions, education, fission products, heat transfer, hot-laboratory practice, industrial hygiene, instrumentation, management, metallurgy, nuclear safety, nuclear-ship propulsion, physics, reactors, waste processing and miscellaneous.

Demonstration Power Reactor Plant will be built as joint venture of AEC and Puerto Rico Water-Resources Authority somewhere on the island. The 16.3-mwe boiling-water-reactor plant will make superheated steam and burn uranium-dioxide fuel. The Authority will provide the site and conventional plant equipment, operate and maintain the reactor on a reimbursable basis and buy steam from the AEC. Plant cost, excluding site, switchyard and power transmission facilities will run about $11 million. The AEC is negotiating with General Nuclear Engineering Corporation; they may do final design of plant. Construction contractor for the reactor and plant will be chosen at a later date.

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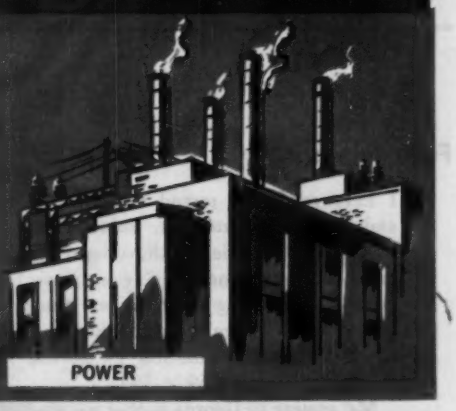

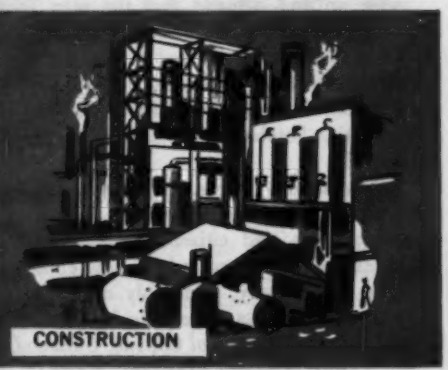

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Reserved for your comment

BOB BELLAS, Associate Editor

First things first

I have read and reread George Edwards' article and I want to state that, unfortunately, the many thousands of people who have been asking the same question for a good many years have had no real method of making their voices heard. It is fortunate that George Edwards has POWER through which to ask the question (*Why not standardize OE exams?*, Dec 1959, p 194).

My answer to George is that we should definitely standardize all operating-engineers' examinations, but aren't we just a little ahead of ourselves? Shouldn't we first have something to take an examination *for* as a standard throughout the country? Please remember that very few of our 50 states have license laws in effect or contemplated. Therefore, shouldn't the first step be either to get operating-engineers' license laws into effect in all the states, or to try to get Congress to pass a national license law for stationary plants as now is in effect in the marine field?

Why the people who must obtain licenses to drive an automobile, a motorcycle and, in some states, an outboard-motor boat or even a bicycle, do not wise up and demand that the man in charge of boilers and unfired pressure vessels, particularly in schools, hospitals and public buildings, be required to have a license is beyond my comprehension. Boilers and unfired pressure vessels are potential bombs in the hands of untrained personnel.

Thank you, George, for starting the ball rolling. Let's see if we can't get our unions, engineering associations and citizens' committees working to eliminate the hazards which now exist through the lack of necessary, preferably uniform, regulations.

J D HOLMES, *Vice-President, Power Plant Div Magnus Chemical Co, Inc, Garwood, N. J.*
(*Past National President, NAPE*)

Waste treatment

George Edwards certainly has a knack for putting his finger on pertinent subjects that plague industry in general and the engineer in particular.

We say "Amen" to his current piece on standardization and the light that it sheds on a most deplorable condition in many plants today (*George Edwards*, Jan 1960, p 168). It's no surprise that the American Standards Association's findings are "eyeopeners" to anyone willing to see the light. It gives some of us sleepless nights to be compelled to live with a situation that is at once wasteful and wholly unnecessary.

Woe to the beleaguered plant engineer who is saddled with a procurement department that eats heavily from the corporation trough, but serves its masters badly by perpetually shopping for "bargains" that wear out too fast, require heavy stocks of parts and are not fully backed by manufacturer's guarantee when things go wrong. Private-plant management has no one to blame but itself for permitting such goings-on year after year.

P C ZIEMKE, *Clinton, Tenn.*

Picking a silicone bone

Your article dealing with silicone insulation may cause trouble for someone if all the facts are not known (*Silicone insulation tackles many jobs in today's electrical equipment*, Nov 1959, p 66).

I suggest that an article cautioning against the use of silicone under certain conditions be published in POWER. For reference, see the November issue of the *Proceedings* of the Merchant Marine Council, U.S. Coast Guard.

H R PENTON, *New Orleans, La.*

EDITOR'S NOTE: *Article referred to in the* Proceedings (*Vol. 16, No. 11, p 220*) *is titled "Silicone materials should not be used in enclosed dc motors and generators." We're grateful to Reader Penton for calling our attention to what he felt was a tactical error on the part of* POWER. *However, we feel that further reference will serve to exonerate us. Suggested reading: "Silicone-insulation vapors can upset commutation,"* POWER, *Nov 1956, p 128.*

Overseas transmission

We were quite interested in your special report, *Electrical Conversion* (Dec 1959, pp 67-90). Based on your statement on p 82 regarding capacity and voltages built in Europe, we believe the enclosed literature on the ASEA system of 100 kv and 20 mw between the mainland and the island of Gotland will interest you.

In addition, we are working on the dc transmission system, cross-channel, between England and France. This will be for transmission in either direction of 160 mw, equivalent to 800 amp dc at 200 kv. It is anticipated that this installation will be ready for commissioning by the end of 1960. Transmission distance is about 38 miles. The converter stations are to be connected from the dc link to the English 275-kv, 50-cps grid and to the French 225-kv, 50-cps grid.

The ASEA dc system, which was selected in the face of severe competition from alternative solutions, offers considerable advantage. The number of transmission cables can be limited, installation

continued on p 88

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This book is not advertising matter, and it contains no catalog data. It is costly to produce and the quantity is limited but plant and building operating and maintenance executives and others who install and maintain valves are more than welcome to a copy. Ask your local Jenkins distributor for it.

THE CONTENTS, and the purpose of this book, are given in the following Foreword; page 1 ...

"Valve economy is an objective of good plant management at all times. It is more important than ever today because of the greatly increased costs of valve replacement and maintenance that have paralleled the rise in all expenses of plant operation.

Most valve failure can be prevented before it starts. But to prevent failure, and insure the efficient operation of valves that contributes to plant productivity, four rules must be constantly followed: proper *selection*, correct *installation*, adequate *inspection*, and experienced *maintenance*.

This booklet has been prepared for plant management and supervisors, to explain and illustrate the principal causes of valve failure, how to prevent similar failures, and how to repair damaged valves. In addition to general instructions for installation and maintenance, it includes several examples of actual valve damage and destruction which have been brought to the attention of Jenkins Engineers. In each case the relatively simple precautions that would have prevented such needless waste are clearly explained, in non-technical language."

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The New Britain Plumbing Supply Co.
New Haven
The C. S. Mersick & Company
New London
Hansen Supply Co.
Norwalk
County Supply Co., Inc.
Norwich
The Anderson Supply Company
Putnam
Rawley Plumbing Supply, Inc.
Stamford
The Connecticut Plumbing Supply Co.
Glauber, Inc.
Waterbury
M. J. Daly & Sons, Inc.

DELAWARE
Lewes
Hajoca Corporation
Seaford
Peninsula Plumbing Supply Co.
Wilmington
Speakman Company

DISTRICT OF COLUMBIA
Washington
Thos. Somerville Company

FLORIDA
Jacksonville
Farquhar Machinery Co.
Lakeland
Mutual Pipe & Supply Co.
Miami
Mayflower Supply Co., Inc.
Railey-Milam, Inc.
Orlando
Hughes Supply, Inc.
Pensacola
May Supply Co.

FLORIDA Cont'd
Tampa
Industrial Supply Corp.
Noland Company, Inc.

GEORGIA
Albany
Engineering & Equipment Co.
Georgia Hdwe. & Supply Co.
Atlanta
Beck & Gregg Hdwe. Co.
Fulton Supply Co.
Grinnell Company, Inc.
J. M. Tull Metal & Supply Co.
Augusta
Noland Company, Inc.
Richmond Supply Co.
Columbus
Columbus Plbg. Htg. & Mill Supply
Hajoca Corporation
LaGrange
Industrial Suppliers, Inc.
Macon
Noland Company, Inc.
Taylor Iron Works & Supply Co.
Rome
Battey Machinery Co.
Savannah
Morgans, Inc.
Valdosta
Whitehead Hardware Co.

HAWAII
Pell Co., Inc.

IDAHO
Boise
Idaho Industrial Supply Co.
Lewiston
Hahn Supply Company

ILLINOIS
Bloomington
Wilkins-Bloomington Company
Champaign
Inland Supply Company
Chicago
Chicago Tube & Iron Company
James B. Clow & Sons, Inc.
Great Lakes Supply Corp.
Fred C. Kramer Co.
Miller Supply Company
Danville
Inland Supply Company
Elgin
Paragon Industrial & Htg. Supply Co.
Metropolis
Metropolis Supply Co.
Moline
Martens-Hodgkin Company
Peoria
Wilkins Pipe & Supply Company
Rockford
D & F Supply Company
Rock Island
Amstan Supply Division (ARS)
Waukegan
Verako Products, Inc.

INDIANA
Anderson
May Supply Company
Evansville
Plumbers Supply Corp.
Fort Wayne
National Mill Supply, Inc.
Indianapolis
Plumbers Supply Corp.
Kokomo
The Main Supply Company
Lafayette
Biggs Pump & Supply, Inc.
Marion
Liniger Company, Inc.
South Bend
The South Bend Supply Co.
Terre Haute
Mechanical Suppliers, Inc.

IOWA
Cedar Rapids
Cedar Rapids Pump & Supply Co.
Des Moines
A. Y. McDonald Mfg. Co.
Plumb Supply Company
Dubuque
Interstate Pipe & Supply Co.
A. Y. McDonald Mfg. Co.
Fort Dodge
Plumb Supply Co.
Marshalltown
Glick Supply Co.
Mason City
Plumb Supply, Inc.
Ottumwa
Iowa Supply Company
Sioux City
Wigman Company
Waterloo
Winterbottom Supply Co.

KANSAS
Wichita
Mid-States Supply Co., Inc.
Phillips & Easton Supply Co.

KENTUCKY
Hopkinsville
Cayce Mill Supply Co.
Lexington
Plumbers Supply Company
Louisville
Belknap Hardware & Mfg. Co.
Neill-LaVielle Supply Co.
Plumbers Supply Company

LOUISIANA
Monroe
Murco, Incorporated
New Orleans
Edgar Murray Supply Co., Inc.
Shreveport
Amstan Supply Co. (ARS)

MAINE
Bangor
R. B. Dunning & Co.
Portland
W. L. Blake & Co.

MARYLAND
Annapolis
Thos. Somerville Company
Baltimore
J. T. Roberts & Bro., Inc.
The Taylor Supply Company
Cumberland
Tri-State Mine & Mill Supply Co., Inc.
Hagerstown
Foltz Manufacturing & Supply Co.

MASSACHUSETTS
Attleboro
Reardon & Lynch Company, Inc.
Boston
Atlantic Pipe & Supply Co., Inc.
Conley Supply Co., Inc.
Pierce-Perry Company
Brockton
Corcoran Supply Co. of Brockton, Inc.
Burlington
A. J. Foltz Company
Cambridge
Boston Pipe & Fittings Co., Inc.
Metropolitan Pipe & Supply Co.
R. C. Sullivan Company
Fall River
Corcoran Supply Co. of Fall River, Inc.
Gardner
Royal Supply Company
Holyoke
The Holyoke Valve & Hydrant Co.
Hyannis
R. B. Corcoran Co. of Hyannis
Lawrence
Bride, Grimes & Co.
Lynn
The Bourneuf Corporation
New Bedford
Babbitt Steam Specialty Co.
Newton Highlands
A. J. Foltz Co. of Newton
Peabody
Bayle Machine & Supply Co.
Jefferson Industrial Supply, Inc.
Pittsfield
Berkshire Mill Supply Co.
South Boston
Charles D. Sheehy, Inc.
Springfield
Charles Miller & Son Co.
Westfield
Warner Supply Company, Inc.
Worcester
Washburn-Garfield Co.

MICHIGAN
Benton Harbor
Brammall Supply Company
Detroit
The Coon-DeVisser Company
Flint
A. P. Engelhart Company
Grand Rapids
Hayden Supply Company
Jackson
Jackson Plumbing & Htg. Supply Co.
The Smith-Winchester Company
Kalamazoo
Galloup Pipe & Supply Co.
Lansing
The Michigan Supply Company
Muskegon
Lakeshore Heating & Plumbing Div.,
Lakeshore Machinery & Supply Co.
Petoskey
Wm. Dunstan Supply Company
Saginaw
Reichle Supply Company

MINNESOTA
Duluth
Duluth Plumbing Supplies Co.
Minneapolis
Central Supply Co.

MISSISSIPPI
Jackson
Harper Foundry & Machine Co.
Nicholas Supply Co.

MISSISSIPPI Cont'd
Meridian
Soule Steam Feed Works
Vicksburg
O'Neil-McNamara Hardware Co.

MISSOURI
Joplin
Joplin Supply Company
Kansas City
Mid-States Supply Co.
Reeves-Wiedeman Co.
No. Kansas City
Grinnell Company, Inc.
St. Joseph
Missouri Water & Steam Supply Co.
St. Louis
Donley Pipe & Supply Co.
Springfield
Thermal Supply Company

MONTANA
Billings
Northwest Pipe Fittings, Inc.
Butte
M & L Supply Company
Montana Hardware Company
Missoula
Montana Mercantile

NEBRASKA
Lincoln
Western Supply Company
Omaha
John Day Rubber & Supply Co.
Midco Supply Co.

NEVADA
Reno
Acme Supply Co., Inc.

NEW HAMPSHIRE
Concord
Page Belting Co.
Keene
Perkins, Bassett & Wright, Inc.
Laconia
J. J. Morin, Inc.
Manchester
Colonial Supply Corp.
Manchester Supply Company
Nashua
F. W. Webb Company, Inc.

NEW JERSEY
Atlantic City
Seashore Supply Co.
Bayonne
Bayonne Plumbing Supply Co., Inc.
Bridgeton
Hajoca Corporation
Camden
Fleck Bros. Co.
Hajoca Corporation
J. D. Johnson Co., Inc.
Elizabeth
Elizabeth Hardware Company
Harrison
Charles F. Guyan, Inc.
National Industrial Supply Co.
William S. Roe
Irvington
Gerweck & Averbocher, Inc.
Jersey City
The Ideal Supply Co.
Lyndhurst
Neill Supply Co., Inc.
Newark
George J. Keller Co.
John Simmons Co., Inc.
New Brunswick
Behrer-Nason Company, Inc.
Raritan Supply Company
North Plainfield
Somerset Plumbing Supply Co.
Orange
Rogers-Ebert Co.
Passaic
Central Engineering & Supply Co.
A. & J. Friedman Supply Co., Inc.
Power Pipe & Supply Co.
Paterson
Federal Supply Corp.
Paterson Supply & Engineering Co.
Perth Amboy
Madsen & Howell, Inc.
Trenton
Manufacturers Selling Co.
Vineland
Endicott Supply Company

NEW MEXICO
Albuquerque
Brown Pipe & Supply of Albuquerque, In
Union Industrial Corporation

NEW YORK
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Sager-Spuck Supply Co., Inc.
Binghampton
Binghampton Industrial Supply Co.
Ellis W. Morse Company
Sage Supply Company, Inc.
Buffalo
Stritt & Priebe, Inc.

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Ithaca
Ithaca Plumbing Supply Company
Jamestown
Clark Hardware Company
Massena
Hyde Plumbing Supply Corporation
Middletown
Orange County Plumbing Supply Co.
Mineola
Behrer-Nason Company, Inc.
Mt. Vernon
New York Plumbers' Specialties Co., Inc.
Newburgh
W. L. Smith Co.
New York, Bronx
New York Plumbers' Specialties Co., Inc.
Standard Plumbing Supply Co.
New York, Brooklyn
Asco Supply Company, Inc.
B. F. Gilmour Co., Inc.
McElroevy & Hauck, Inc.
Salster & Weinsier, Inc.
Simplex Plumbing Supply Co., Inc.
The Smyth-Donegan Company
John Wilfert Company
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Davis & Warshaw, Inc.
Glauber, Inc.
Charles F. Guyon, Inc.
Herbert Rack Supply Corporation
Sidney Samuels, Inc.
Smolka Co., Inc.
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Mayer Malbin Co., Inc.
New York, Staten Island
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Niagara Falls
Case-Elderfield, Inc.
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North White Plains
Behrer-Nason Company, Inc.
Ogdensburg
Utica Plumbing Supply Company, Inc.
Olean
Case Div. of Raub Supply Co.
LeValley McLeod, Inc.
Portchester
Central Plumbers Supply Co., Inc.
Poughkeepsie
Interstate Plumbing Supply Co., Inc.
J. D. Johnson Co., Inc.
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Haverstick & Company, Inc.
Syracuse
Burns Bros.
Case Industrial Supply, Inc.
Utica
Charles Millar & Son Co.
Yonkers
Glauber, Inc.
Joseph C. Ryan & Sons, Inc.

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Charlotte
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Grinnell Corporation
Hajoca Corporation
Industrial & Textile Supply Co.
Durham
Dillon Supply Co.
Noland Company, Inc.
Fayetteville
Piedmont Supply Co.
Gastonia
Gastonia Mill Supply Co.
Goldsboro
Dillon Supply Co.
Greensboro
Hajoca Corporation
Piping & Equipment Supply Co.
Hickory
Anchor Supply Co.
High Point
Kester Machinery Co.
Kinston
Noland Company, Inc.
Raleigh
Dillon Supply Co.
Noland Company, Inc.
Standard Supply Co.
Rocky Mount
Dillon Supply Co.
Salisbury
Piedmont Mill Supply Co.
Shelby
Shelby Supply Co.
Wilmington
Mill & Contractors Supply Co.
Wilson
Noland Company, Inc.
Winston-Salem
Kester Machinery Co.
Noland Company, Inc.

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Bellaire
Pittsburgh Gage & Supply Co.
Canal Fulton
H. J. Rothwell Fitting Company, Inc.
Canton
Mahoning Valley Supply Company
Chillicothe
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Cincinnati
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Cleveland
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Columbus
McJunkin Corporation
Westwater Supply Company
Dayton
The W. H. Kiefaber Company
Hamilton
The W. H. Kiefaber Company
Lancaster
The Raedel Hardware Company
Lima
Amstan Supply Division (ARS)
Lorain
Amstan Supply Division (ARS)
Mansfield
Amstan Supply Division (ARS)
Marietta
McJunkin Corporation
Sandusky
Brohl and Appell Company
Steubenville
Industrial Supplies Corporation
Toledo
The Hardy & Dischinger Company
Youngstown
Valley Pipe & Supply Company
Zanesville
Industrial Supplies Company

OKLAHOMA
Oklahoma City
Mideke Supply Company

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Astoria
Fisher Bros.
Eugene
American Steel & Supply Company
Medford
American Steel & Supply Medford, Inc.
North Portland
Moore Dry Kiln Company
Portland
Goodyear Rubber & Supply Co.
J. E. Haseltine Company
Paramount Supply Company
Salem
Salem Steel & Supply Co.

PENNSYLVANIA
Allentown
Lehigh Valley Supply Co.
Altoona
Pittsburgh Gage & Supply Co.
Bethlehem
Hajoca Corporation
Easton
H. P. Kinsey Company
Erie
Amstan Supply Division (ARS)
United Industrial Supply Company
Harrisburg
Appleby Bros. & Whittaker Co.
Haverford
Plumbers Supply Co., Inc.
Lancaster
Herr and Company, Inc.
Lansdale
Hajoca Corporation
Lewisburg
Buffalo Valley Supply Co.
Lewistown
Krentzman Supply Co., Inc.
Norristown
Barker Pipe Fittings Co.
Philadelphia
Herman Goldner Company, Inc.
Grinnell Corporation
Henry B. Pancoast Co.
C. J. Rainear Co., Inc.
Pittsburgh
Pittsburgh Gage & Supply Co.
Pottsville
Reading Foundry & Supply Co.
Reading
Hajoca Corporation
Reading Heater & Supply Company
Scranton
Ralph E. Weeks Co., Inc.
Sharon
Pittsburgh Gage & Supply Company
Titusville
Pittsburgh Gage & Supply Company

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Williamsport
E. Keeler Company
York
P. A. & S. Small Co.

RHODE ISLAND
Cranston
Grinnell Corporation
Providence
Allen & Reed Company
Rhode Island Supply and Engineering Co.
Woonsocket
Woonsocket Supply Co.

SOUTH CAROLINA
Anderson
Sullivan Hardware Co.
Charlestown Hgts.
B. L. Montague, Inc.
Clinton
Industrial Supply Co.
Columbia
Columbia Supply Co.
Noland Company, Inc.
Florence
O'Brian-Mace Company
Greenville
Poe Hardware & Supply Co.
Stewart Supply Co.
Spartanburg
Noland Company, Inc.
Spartan Industrial Supply Co.

TENNESSEE
Chattanooga
Mills & Lupton Supply Co.
Jackson
Southern Supply Co.
Kingsport
Greene Hardware & Supply Co.
Knoxville
Tennessee Mill & Mine Supply Co.
Memphis
E. C. Blackstone Co.
Cotton States Supply Co.
Nashville
Buford Brothers, Inc.
Noland Company, Inc.

TEXAS
Austin
K. & M. Supply Co. of Austin
Corpus Christi
Corpus Christi Hardware Co.
El Paso
Electrical & Mechanical Supply Co., Inc.
Zork Hardware Company
Fort Worth
Well Machinery & Supply Co.
Houston
Corbett Corporation
Marshall
E. B. Hayes Machinery Co.
Paris
Robert L. Swaim Co.
Port Arthur
Oil Industry Supply Co., Inc.
San Antonio
San Antonio Pipe & Supply Co.
Southern Equipment Co.
Texarkana
Buhrmann-Pharr Hardware Co.
Wichita Falls
Wichita Supply Co

UTAH
Provo
Provo Plumbing & Heating Co.
Salt Lake City
Mountain States Supply Co.
Peerless-Utah Company

VERMONT
Barre
Warner-Turner Supply Co., Inc.
Burlington
The Blodgett Supply Co., Inc.
Rutland
Canney-Plue, Inc.
St. Johnsbury
Charles Millar & Son Co.
White River Junction
Shepard Corporation

VIRGINIA
Bristol
Mitchell-Powers Hardware Co.
Charlottesville
Noland Company, Inc.
Danville
Hajoca Corporation
Fairfax
Thos. Somerville Company
Lynchburg
Barker-Jennings Corporation
Noland Company, Inc.
Newport News
Noland Company, Inc.
Norfolk
The Henry Walke Company
Richmond
Hajoca Corporation
Industrial Supply Corporation
Noland Company, Inc.
Southern Railway Supply Co.
Roanoke
Graves Humphreys Hardware Co.
Noland Company, Inc.
Staunton
Hajoca Corporation
Waynesboro
Mize Supply Co.
Wytheville
Hobart N. Grubb, Inc.

WASHINGTON
Olympia
Olympia Supply Company
Seattle
Northern Commercial Co.
Puget Sound Pipe & Supply Co.
Steam Supply & Rubber Co.
Spokane
M & L Supply Company
Tacoma
Paramount Supply Company
Walla Walla
Drumheller Company
Yakima
Krum Industrial Supply, Inc.

WEST VIRGINIA
Charlestown
McJunkin Corporation
Stainless Piping Supply, Inc.
Clarksburg
Osborn Machinery Co., Inc.
Huntington
Foster-Thornburg Hardware Co., Inc.
Logan Hardware & Supply Co.
Logan
Logan Hardware & Supply Co.
Parkersburg
Pittsburgh Gage & Supply Co.
Ronceverte
Cheuvront's Supply, Inc.
Weston
Danser Hardware & Supply Co.
Wheeling
Trimble & Lutz Supply Co.

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Appleton
I. Babcall, Inc.
W. S. Patterson Co.
Green Bay
Murphy Supply Company
Iron Mountain
Wittock Supply Company
Kenosha
P. H. & I. Supply Co.
La Crosse
W. A. Roosevelt Co.
Madison
Automatic Temperature Supplies, Inc.
Manitowoc
William Rathsack & Sons Co., Inc.
Milwaukee
F. R. Dengel Company
B. Hoffman Mfg. Co.
Rundle-Spence Mfg. Co.
Nekoosa
Nekoosa Foundry & Mach. Works, Inc.
Oshkosh
Battis Bros. Supply Co., Inc.
Racine
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Wausau
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VALVES
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Jenkins Bros

costs are lower and the likelihood of mechanical faults is less. Further, the dc link will enable network frequency of the one country to be regulated independently of that in the other.

FINN DAHLIN
ASEA Electric, Inc, New York, N. Y.

Try a sigma chi transformer, maybe?

I got a bang out of the story concerning the joker who put black powder in the fuses ("What would you have done?" Jan 1960, p 191). Now I've heard everything.

So far as taking care of situations like this properly, there are a number of factors involved. Conventional starting compensators for 3-phase motors are normally equipped with only two overload relays so that one leg is unprotected. Under normal circumstances this is adequate.

However, if the transformer supplying power to the unit is connected Y-delta or delta-Y, and there is an open phase on the primary, current on one of the three secondary legs will be doubled. If it happens that this doubled current occurs in the unprotected leg, then that phase winding of the motor will be burned out and the overload relays will not take the motor off the line in sufficient time. This won't happen if the transformer connections are straight delta-delta. With such connections I have run tests on induction motors, deliberately single-phasing them under load. Under normal conditions, the overload relays will disconnect the power in about 10 or 15 minutes. During that period of single-phase operation winding temperatures will not be excessive.

The whole problem can be avoided by installing three-phase overload protection so that all three legs are protected. However, this substantially increases motor-control cost. If it's a low-voltage system (under 600 v), time-lag fuses can be installed at 125% of full-load motor current rating. A well-known fuse on the market incorporates a heating element capable of withstanding motor starting current. If the current remains high beyond a normal period the fuse will blow.

With the Y-delta connection, one phase is already gone out to create your single-phase connection. The doubled current in one of the two remaining legs will immediately blow the fuse in that leg, dropping the motor off the line. We have found this to be the simplest and most economical protection for this type of system.

Motor-overload relays should be frequently checked and tripped manually to insure that they're not mechanically jammed. We have found even brand-new starters with overload relays mechanically jammed, probably due to careless assembly. This points up that it's always wise to inspect them carefully before putting them in service.

J B MURPHY, *Peoria, Ill.*

We used a large sparge

We enjoyed the article covering the report by Alf Kolflat, Senior Partner of Sargent and Lundy, on tests they ran to study effects of cold water on flashing-steam pressures (*Tests point way to cutting containment costs*, Dec 1959, p 99).

Our proposal for the Army Package Power Reactor, Nov 17, 1954, included a cost-cutting containment scheme whereby flashing vapors from a reactor-loop failure were vented to a "sparge tank" which was buried outside of the reactor building. This vessel contained water in which a sparge pipe was placed near the bottom below the liquid surface. Free volume of the sparge tank and the quantity of liquid in the tank were calculated to limit final pressure in the total system volume to 50 psig. This arrangement, we believe, resulted in a containment volume about one-tenth of that required by a lower-pressure vessel with no water quenching. Above 50 psig the rapidly diminishing reduction in volume did not appear economical considering extra difficulty of holding the higher pressure. We checked our boiling-water to cold-water ratios against those in the article and found reasonable agreement considering difference in size.

It is encouraging to read about such tests and the support they are receiving. This type of activity can contribute much to the cost reduction of our national nuclear-reactor program.

GEORGE C HAHN
The Stearns-Roger Mfg Co, Denver, Col.

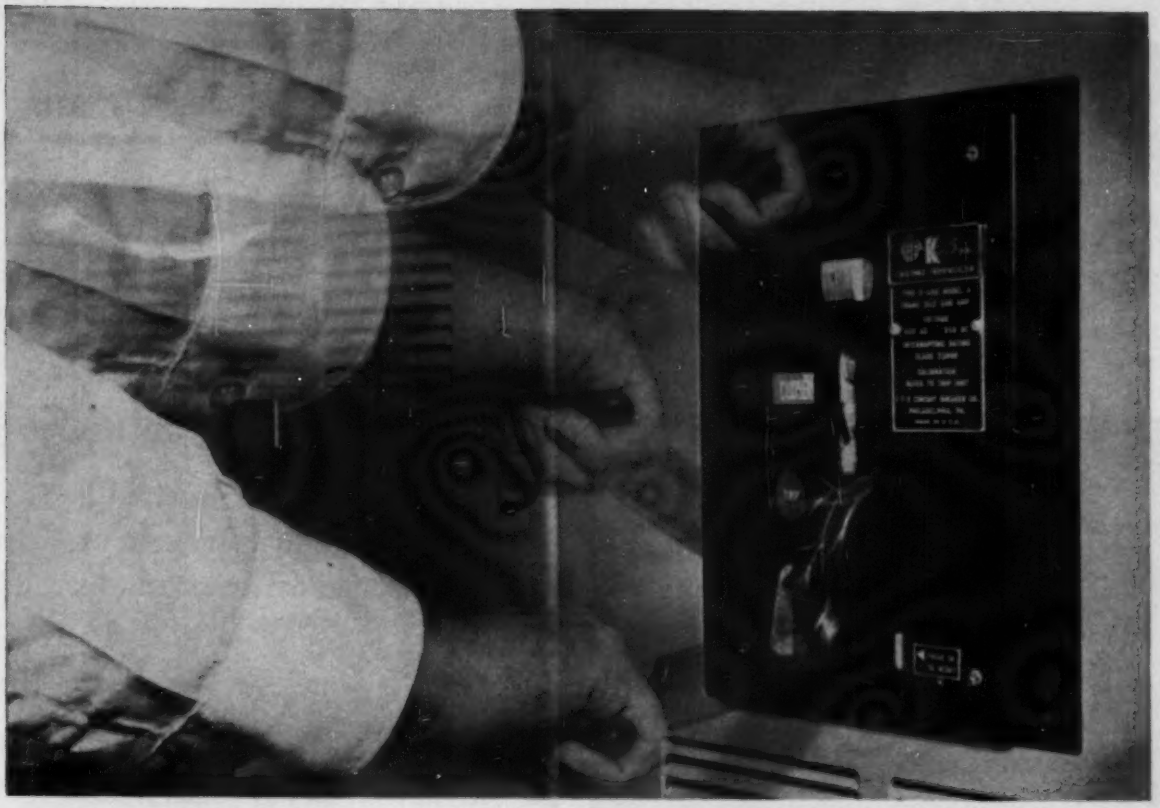
A shifty deal

In your January issue you printed a letter from Reader *WAG* dealing with shift-personnel problems ("How can we schedule shift operation?," *Plant problems*, p 189).

I can't offer any specific solution because we're in the same boat. All I can say is, "welcome to the club." This appears to be a common problem among power plants. It seems as though plant management doesn't think it's necessary to completely cover shift hours, but can depend on operators working overtime to take up the slack in emergencies. Obviously such plants are undermanned.

With so much money invested in power plants today, and with such accent on maintenance and preventing outages, it seems odd that management policy in many cases doesn't provide for possible "outages" among shift personnel.

R E GRAEFEN, *Riverdale, Ill.*



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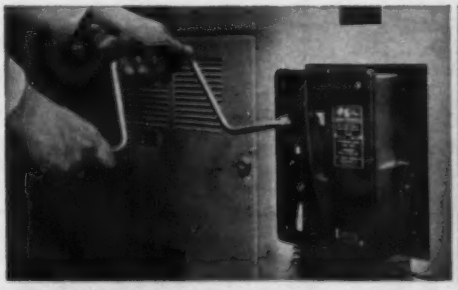


Closed door disconnect. A real safety feature. Operator can rack breaker out to either test or disconnect position without opening door. Prevents cluttered aisles from open doors and protruding breakers. And keeps breakers clean when they are disconnected.

Expanded range trip. I-T-E breakers can grow with your loads. Each trip device has roughly three to four times the range of conventional devices. Saves cost and downtime that replacement would demand. Easy to adjust. Calibrated directly in amperes.

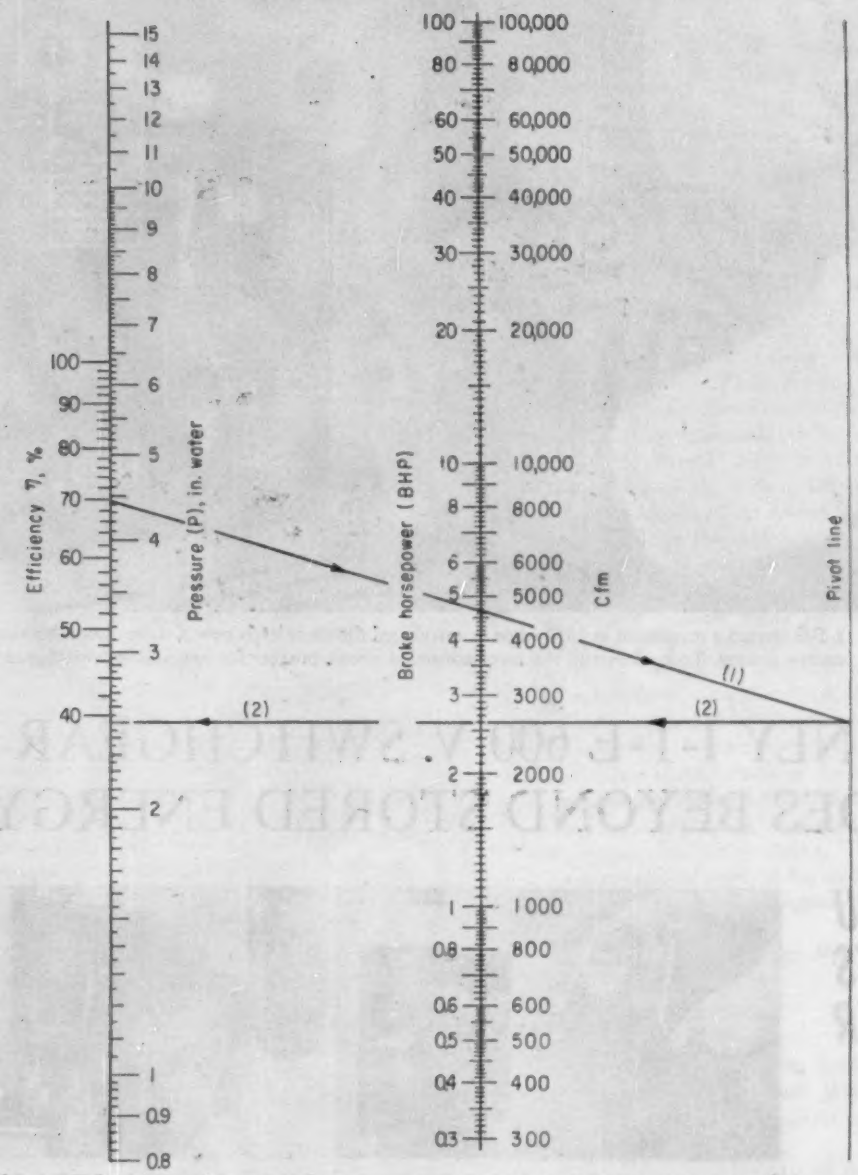
You pay no more. That's right. With all these extra advances I-T-E low voltage switchgear costs no more. Send for detailed descriptive Bulletin 6004-C. I-T-E Circuit Breaker Company, Dept. SW, 1900 Hamilton St., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY

For more facts circle 236 on Reader Service card, p 109

Power's data sheet

No. 331



Nomograph for calculating fan horsepower

Nomograph is based on standard formula for fan power:

$$Bhp = \frac{0.01573 \times cfm \times p}{\eta}$$

When scale values of either *cfm* or *p* are multiplied by N_1 and N_2, then scale value of *bhp* must be multiplied by the same factors to obtain final answer.

Example: What brake horsepower will a 70%-efficient fan require to deliver 46,250 cfm at 2.5-in. H_2O?

Solution: Align $\eta = 70\%$ with $cfm = 4625$ (actual $cfm \div 10$) and continue to pivot line. From pivot intersection, extend line to $p = 2.5$. Read intersection of *bhp* as 2.6 and correct for scale factor applied to *cfm*. Final answer is $bhp = 2.6 \times 10 = 26$.

F CAPLAN, *Oakland, Calif.*

© POWER

News and Notes on...

Good Packing Practice

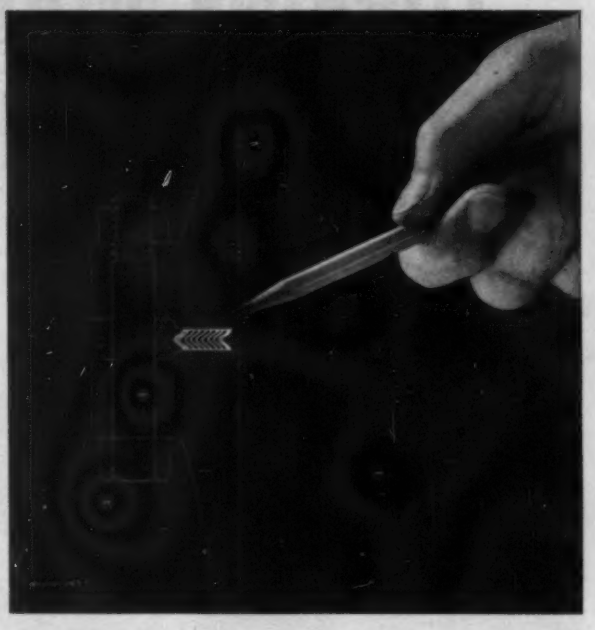
JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

Subject of the month: Selecting the Gasket

Question:

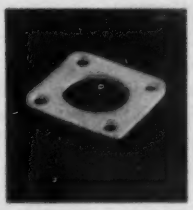
What are the important points to remember about gasket applications so we can avoid costly failure?



GASKET engineering is a complex study, but there are certain simple answers to this commonly asked question. Briefly, at least three variables must be considered. These are: 1. The available bolt force on the gasket. 2. Internal pressure and temperature. 3. The nature of the contained fluid.

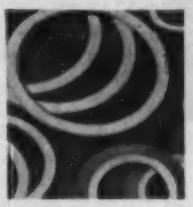
Starting with bolt force: it must be adequate to flow the gasket material and cause it to yield and seat effectively. Secondly: the bolt force must also always be sufficient to exceed the internal pressure and temperature forces that work against gasket closures. Finally: the gasket material must be impervious to the action of the confined fluid.

For service at low to medium temperatures and pressures: As a rule of thumb, if multiplying the operating pressure (psi) by operating temperature (°F) results in a product not exceeding 250,000, a quality "general service" type gasket can be used with complete safety. An outstanding gasket material for these operating conditions is J-M Service® Sheet #60 . . . a tough, durable compressed asbestos sheet. Service Sheet seals effectively against hot or cold water, steam, oils, mild acids and caustics.



If corrosive fluids are encountered: The best solution to the constant attack of chemicals and solvents is a gasketing material that is chemically inert. For this kind of service condition, Johns-Manville Teflon* Chempac® Gaskets are recommended. They are available in pure Teflon, low-flow Teflon-Asbestos, and in metal-(glass-filled) Teflon, Teflon combinations.

*TM for DuPont Tetrafluorethylene resin.



When extreme pressures and temperatures act on the gasket: If internal pressures reach 1200 psi or temperatures exceed 850°F, safe practice calls for a sturdy gasket that offers the high resiliency needed to follow expanding and contracting movements of flanges. For standard flange applications to 6,000 psi, you will find metal-asbestos, spiral-wound Goetze Spirotallic® gaskets most efficient. They offer high mechanical strength and resilience. Their special interlocking design and stainless steel construction is especially designed to effect and maintain a tight seal despite wide pressure and temperature variations.

To solve any sealing problems, call your J-M Packings and Gaskets field representative. He's equipped to give you information on new products . . . engineering and design advice. For information on any J-M Packings or Gaskets write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

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For more facts circle 237 on Reader Service card, p 109

(Advertisement)

WORLD'S TWO OLDEST TURBINE MAKERS COMBINE FORCES

Stockholm, Sweden—It was announced recently that the AB de Lavals Angturbin (Swedish de Laval Steam Turbine Co.), world's oldest makers of axial steam turbines, and the Svenska Turbin AB Ljungström (STAL), world's oldest makers of radial steam turbines, have merged into a new corporative unit called the de Laval Ljungstrom Turbine Co.

It was in 1883 that Gustaf de Laval took out his first patent for the high-speed axial steam turbine

Fredrik Ljungström

on the impulse system with expanding nozzle, flexible shaft and double helical gear. The first series of de Laval turbines for commercial use were built in 1892. Soon after the AB de Lavals Angturbin was founded with works near Stockholm.

Some 15 years later Birger Ljungström invented the radial steam turbine on the double rotation principle. His brother Fredrik Ljungström made the practical construction of the turbine possible through his many ingenious designs. The Svenska Turbinfabriks AB Ljungström was formed in 1913 to exploit the STAL turbine.

Gustaf de Laval

Joint Land and Sea Operations

During the years the de Laval turbine has come to use as a prime mover for both land and marine purposes. de Laval marine propulsion units are now being built up to 28,000 shp. Naval units with an output per shaft up to 45,000 shp have been built for several navies. A close technical cooperation is carried on between de Laval in Sweden and its American namesake in Trenton, N. J., together with ten licencees around the world.

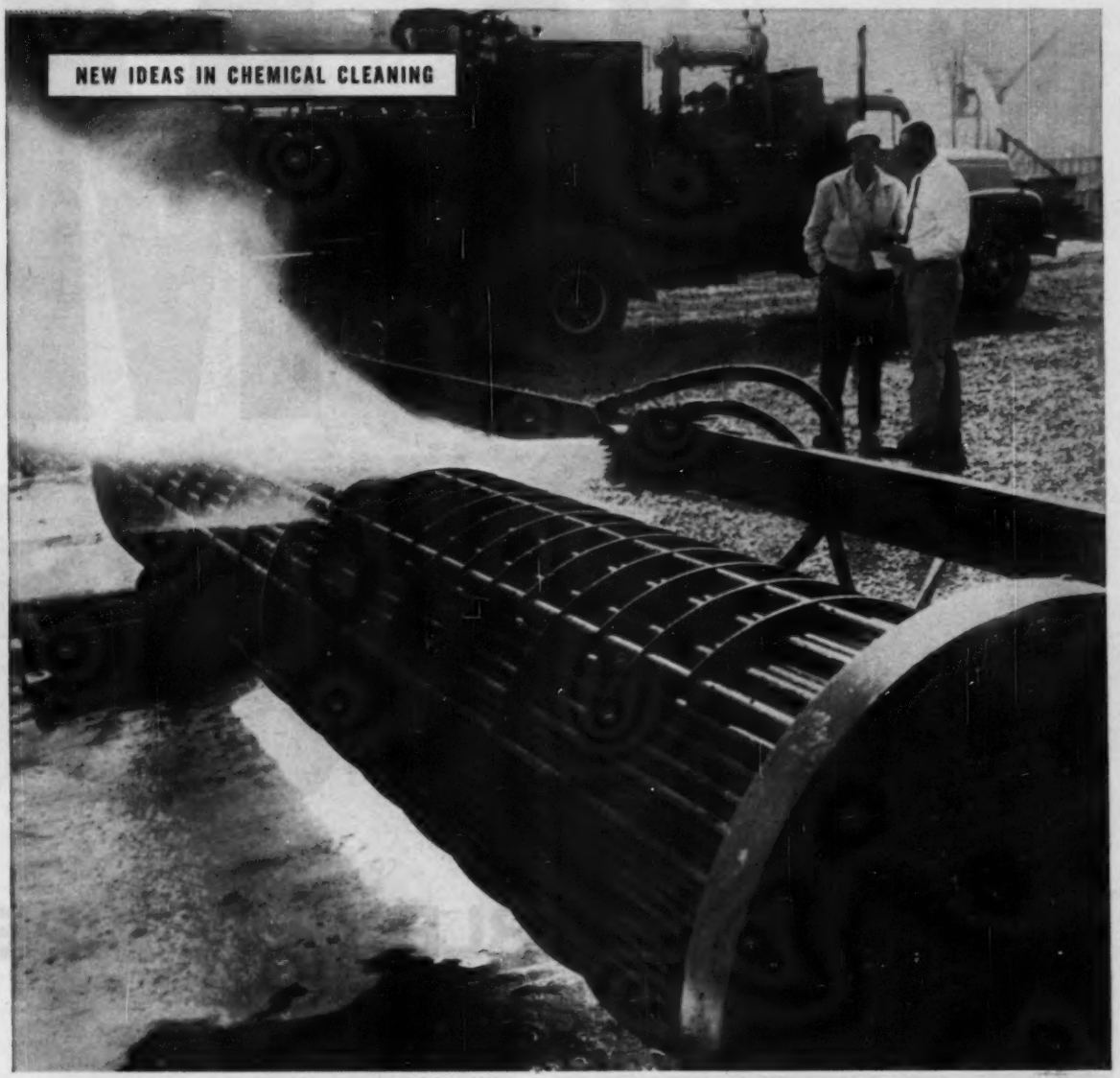
The STAL turbine has found its place in the world's large steam power stations such as the two 150,000 kW turbines at Stenungsund, Sweden, the 80,000 kW plant at Odense, Denmark, and the 60,000 kW turbines for Port Augusta, South Australia, and Rotterdam in the Netherlands. The STAL network of sales offices extends over 49 countries.

"L'union fait la force"

The present merger enables the two companies to pool their vast

Birger Ljungström

resources in research, design, construction, installation and service to serve the entire field of land and marine steam power, with an outstanding array of steam turbines, gas turbines and auxiliary machinery such as pumps, refrigerating machinery etc. Address your inquiries to the de Laval Ljungstrom Turbine Company, Finspong, Sweden.



New Jetting Tool To Clean Tube Bundles Saves Thousands Of Dollars

The new high-pressure hydraulic tool, shown above, is currently saving thousands of dollars for companies in the refining, chemical, and petrochemical industries. It is the jetting tool developed by Dowell to remove deposits from heat exchanger tube bundles.

Previous methods of cleaning these bundles have been costly, time-consuming and often inadequate. Many times bundles had to be replaced completely because of the lack of a suitable cleaning method.

This new tool has a remarkable record of thorough, fast cleaning. For example, a slurry reboiler exchanger bundle, three feet in diameter and 16 feet long, was fouled with deposits of coke and asphalt. After being jetted from only one side, the bundle was thoroughly clean. Time required: less than one hour.

The tool holds the bundle in place for cleaning and has flanged rollers for rotation. The jet-head is manipulated automatically so that all tube spaces are covered. The jetted liquid can be either water or chemical solvents.

The new Dow Industrial Service Division will continue to offer the service which was formerly provided through the Dowell Division. For engineered recommendations to solve your cleaning problems contact the field office nearest you, or write Dow Industrial Service, 20575 Center Ridge Road, Cleveland 16, Ohio.

DOW INDUSTRIAL SERVICE

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For more facts circle 239 on Reader Service card, p 109

K&M ZEBRA

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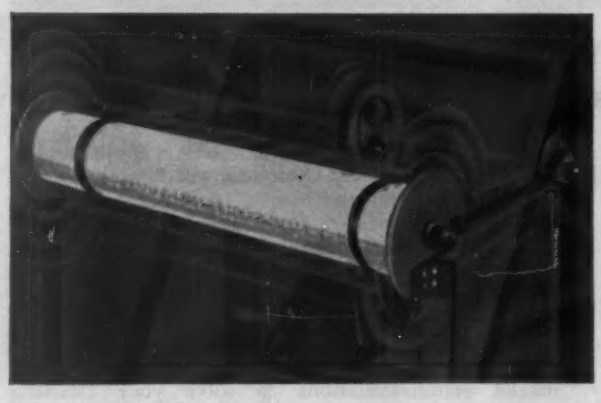

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ZEBRA won't warp or crack! "K&M" tested ZEBRA to simulate working conditions in which equipment would be used.

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for temperatures of 200°F to 1200°F

Remarkable new "K&M" ZEBRA is a low, medium, and high-temperature pipe insulation, available sectionally in a wide variety of pipe sizes and thicknesses.

It has come through with flying colors in tests conducted by both "K&M" engineers and an independent testing laboratory.

These tests prove that "K&M" ZEBRA withstands shock and heat without warping or cracking. It's quick and easy to handle and install . . . with minimum loss due to breakage. In addition, "K&M" ZEBRA meets your requirements for density, conductivity, modulus of rupture, and the ability to withstand soaking heat.

"K&M" ZEBRA is a multi-layer sectional-type thermal insulation primarily composed of calcium silicate-asbestos fiber bonded felts. It's the result of long "K&M" experience in the manufacture of high- and low-pressure insulations, pipe and block insulations, cements, and textiles.

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Technical briefs . . . Latest engineering

Russians outline 7-year plan: power growth, industrial turbines and water treatment

Tasks in the construction of thermal-electric power stations in 1959-65, *I T Novikov, Minister, Ministry of Power Station Construction, U.S.S.R.*

By the end of the current 7-year plan, electrical output in the U.S.S.R. will be 500 to 520 million kwhr. This is 120% greater than 1958 and means the addition of 60-million-kw installed capacity. Use of natural gas and oil will rise from 31 to 51% and coal will drop from 60 to 43%. About 81% of the new capacity will be thermal because of lower installed cost per kw.

Recent new capacity has been installed in unit sizes of 25 to 150 mw and stations of 200 to 600 mw. New construction will be in 100- to 300-mw unit sizes and new stations will contain up to 2400 mw. First 200-mw unit is now installed in Yuzhno-Ural'skaya GRES. By the end of the current 7-year plan the first 500- to 600-mw units will have been installed. Current standard steam conditions of 1280 psig, 930 F will move up to 1850 psig, 1050 F reducing specific fuel consumption by 12 to 14%. Further increases to 2400 psig, 1075 F will give an additional 4 to 6% economy gain.

Reductions in construction time from present 45 to 47 months by 12 to 18 months for coal and 18 to 26 months for oil and gas are foreseen. This will require more extensive prefabrication.

By 1965 combined heating and generating plants will produce 1.19-billion Btu vs 415-million Btu in 1958. Gas-turbine units of up to 100 mw will be installed near main gas pipelines in the next 7 years. First 1300-F 50-mw sets scheduled for 1960 will have overall efficiency of 29%. Later 1460-F units will increase efficiency to 33.5%. *Teploenergetika, 1959, No. 5 (5 pages)*

The use of supercritical steam conditions in heat and electric power stations, *K A Rakov, All-Union Thermo-Technical Institute, U.S.S.R.*

Increased housing construction and its central steam-heating load is not fully considered in design of new power plants. Separate central-heating facilities are becoming more popular.

Supercritical topping units in existing plants should be considered where both electrical and steam-heating loads are increasing. This increases efficiency over separate facilities. Since 575-F feedwater is required for once-through supercritical boilers and more steam is needed to drive the boiler-feed-pump turbines, bleed steam should be taken from the supercritical turbine exhaust for these purposes. Plant must add another stage heater in addition to the new steam generator, boiler-feed pump and turbine generator.

Old drum boiler may be retained for peak steam-heating loads, but economizer must be bypassed.

Present false evaluation of new combined supercritical heat and power plants sometimes results from failure to include cost of new mines and transport needed in figuring total capital investment. Savings in mine and transport costs because of improved heat rate often offset higher capital investment in the plant itself. This is not true, however, in gas-fired plants located near natural-gas fields. Several sample evaluations illustrate these conclusions. *Teploenergetika, 1959, No. 5 (7 pages)*

Steam conditions, types and typical sizes of steam turbines for industrial thermal-electric power stations, *A N Kuranov, Industrial Power Project, U.S.S.R.*

For next 10 to 15 years industrial power plants providing process steam as well as electric power will be limited to 6 to 25 mw because of extensive construction of new regional power plants.

Present industrial-turbine standards (GOST-3618-58) provide for initial conditions of 500 psig, 820 F to 1280 psig, 1000 F. Actual installed throttle conditions run from 212 psig, 600 F up to the bottom of the standard range. Standard bleed pressures don't agree with process demands either. Survey reveals 71% of process demand is 43 to 113 psig and 25% is 121 to 256 psig. Both the Bryansk and Leningrad Metal Works can provide non-standard turbines to meet actual process needs.

Standards should therefore be changed to agree with usual industrial process and electrical demands. *Teploenergetika, 1959, No. 5 (5 pages)*

A conference on the use of steam-gas installations with high-head steam generators. *U.S.S.R.*

Conference of utility and manufacturing engineers on combined cycles called by Commission of the Council of Ministers produced several interesting conclusions. In high-pressure units fuel consumption can be trimmed by 12% or thermal efficiency increased 1 to 2%. Response to load change is more rapid than in conventional cycles; installed cost per kw is less. In future combined cycles, turbines need not be bleed type.

Central Boiler Institute designs for combined-cycle pressurized boilers include capabilities of

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50,000 to 450,000 lb per hr and weight reductions of 25 to 30% compared to conventional types.

Velox (made by Brown-Boveri) boiler operation was reported, including field modifications found necessary. Conference members urged Russian development of large gas turbines. Leningrad Metal Works can build 12-mw sets for 2-year delivery. *Teploenergetika, 1959, No. 5 (6 pages)*

Operating experience with demineralizing installations, *Ya M Ostrovskiy, L A Chernova, A V Aseyeva, Mosenergo Power System, U.S.S.R.*

First demineralizing plant was installed in the Mosenergo power system in 1941; now five of these plants are in operation. Their physical layout is described and operating results are tabulated. Standard plants consist of a cation exchanger, degasser and strong-base anion exchanger.

Considerable success is reported in removal of silica, but mechanical strength of anion resins is lacking. Organic fouling of resins has been a problem. *Teploenergetika, 1959, No. 2, (11 pages)*

A new type of nontubular regenerator for gas-turbine installations, *A P Salikov, S V Glazov and N P Klitin, All-Union Thermo-Technical Institute, U.S.S.R.*

Present gas-turbine regenerator designs, both Soviet and foreign, have many shortcomings. Some are heavy and bulky. Other rotating types, while lighter and smaller, permit hot-air leakage.

New design developed by All-Union Thermo-Technical Institute provides cold-rolled ribbed plates assembled so that air and gas flow through alternate channels. Either rectangular or cylindrical units can be built up from ribbed plates into unit regenerators. No manufacturing difficulties have been encountered.

Operating characteristics and design details are given for 25-mw regenerators. *Teploenergetika, 1959, No. 8 (5 pages)*

Problems in the design of combined cation water-purification installations with magnesium desilication, *A A Krupchitskiy, Khar'kov Division, Heat-Power Project Institute, U.S.S.R.*

Magnesium desilication of feedwater is applicable in power plants using pressures up to 1400 psig. At higher pressures, a combination of cation exchange and evaporation is recommended. For industrial power plants providing process steam, the Ministry of Power Plants recommends that normal operating conditions should govern type of water-treatment process selected. But emergency conditions should govern plant design output.

A specific 2000-psig plant is discussed. Author concludes that the 2-step water-treatment process is best. A schematic layout of plant is shown and details of standardized chemical handling given.

Currently, fully automatic control of large water-treatment plants is considered uneconomical because of high initial cost and difficulties in correcting design and construction defects. *Teploenergetika, 1959, No. 7 (6 pages)*

Directions for ordering these papers on page 104

Utility expansion

Decentralized peak-shaving . . . its economic significance to electric utilities, *C W Bary, Philadelphia Electric Company*

This approach to peak-shaving is a rational study based on various combinations of factors. Factors include: (1) anticipated load growth (2) system load factor (3) amount of peak-shaving (4) trends in unit sizes and efficiencies (5) trends in prices and (6) additional capacity requirements.

General equation gives savings for a particular peak-shaving policy as the difference between savings in annual operating costs and annual fuel penalty. Usually a declining-load-factor situation produces greatest peak-shaving savings.

Decentralization of peak-shaving capacity minimizes line costs but requires automatic remote control and a high degree of reliability. Manufacturers of diesel and gas-turbine peak-shaving units must improve noise and exhaust-odor control to permit installation in residential areas. *ASME 59-A-283*

Strategy for expansion of utility generation, *D N Reps, Westinghouse Electric Corp and J A Rose, Public Service Electric & Gas Corp*

Ever-increasing generator unit sizes and costs require highly accurate forecasts. Cost of error in planning utility expansion is prohibitive.

This approach to system planning involves four steps: (1) formulation of alternative *policies* (2) selection of suitable *patterns* to implement each policy (3) calculation of system-expansion *plans* applicable to each expansion pattern (4) *strategic analysis* of the alternative plans to pick the best one.

An example of the process shows maximum allowable capital investment that can be prudently spent to obtain benefits of technological advances in reduced heat rates.

Technique is also adaptable to other evaluation processes such as determination of fuels to be used, reliability of system components, selection of voltage and rate of plant retirement. *AIEE 59-1161*

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Technical briefs

Begins on page 96

Hydraulic turbines

Reversible pump-turbines at Niagara Falls, *F E Jaski and W W Weltmer, Allis-Chalmers Manufacturing Co*

New York State Power Authority's new Tuscorora pumped-storage plant will include 12 pump-turbines rated at 3400 cfs against 85 ft at 112.5 rpm. Lewiston Plant downstream will contain 13 turbines each rated at 200,000 hp under 300-ft head. The new power-development project at Niagara Falls results from 1950 treaty between Canada and United States.

Model tests of the pump-turbine show transient behavior in case of power failure as well as overall performance and cavitation characteristics. Wicket-gate-moment problems resulting from the 2-directional flow were solved through extensive model-test trial runs. Test results are given and discussed in detail. *ASME 59-A-87*

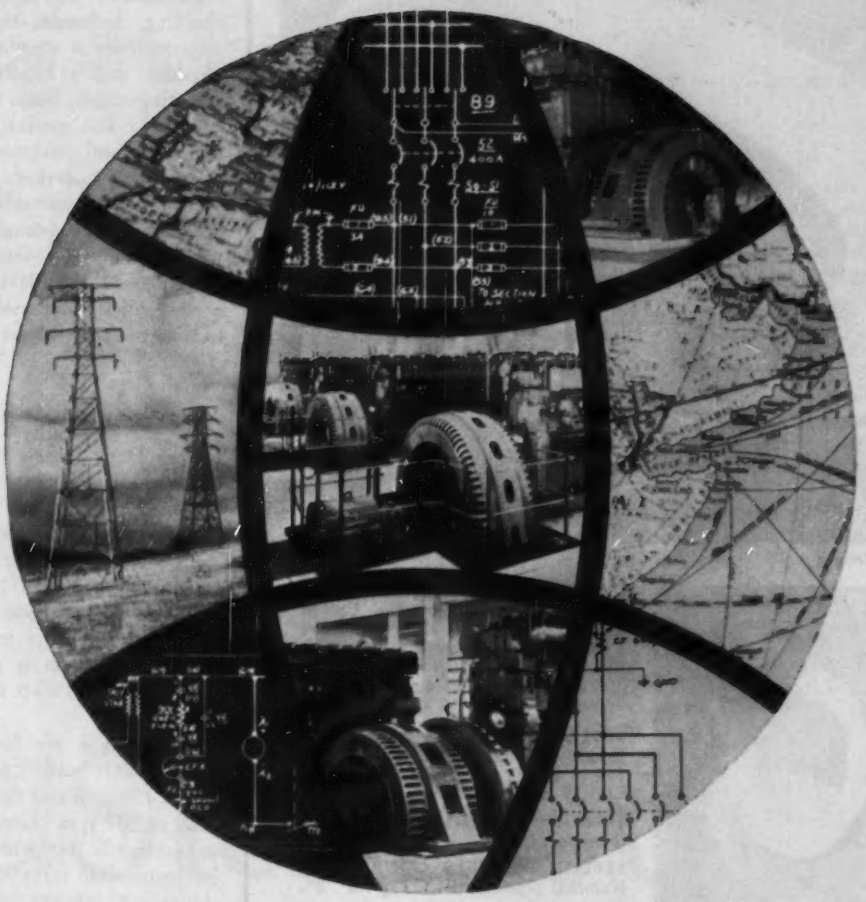
Centrifugal pumps used as hydraulic turbines, *C P Kittredge, Princeton University*

Centrifugal pumps can be used as hydraulic turbines for low-power applications where minimum cost is more important than high efficiency. Sample calculations are shown to illustrate method of basing performance as a turbine on pump-characteristic curves.

Use of affinity laws over a wide range as in this method of turbine selection reduces degree of accuracy obtained. Selection of pumps as turbines should be confirmed by test. *ASME 59-A-136*

Simplified instrumentation and field check of hydraulic-turbine governors, *B E Wheeler, Baldwin-Lima-Hamilton Corporation*

Rapid development of load-frequency-control systems demands that hydraulic-turbine governors give peak performance at all times. Governors can no longer be regarded as



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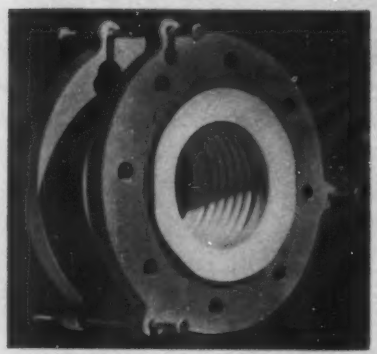

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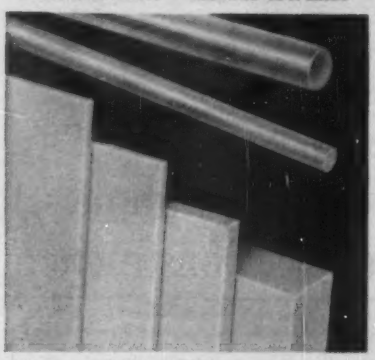

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Technical briefs

Begins on page 96

"black boxes"—not to be touched.

Necessary instrumentation for checking hydraulic-turbine governors includes a standard frequency recorder and a locally constructed actuating stand. Basic testing should cover (1) lost motion between turbine gates and servomotor (2) effectiveness of governor dashpot (3) speed-droop characteristics and (4) operation of speed-sensing and relay-valve sections of governor.

Permanent records of test results permit quick comparison from time to time to spot changes in operation. *ASME 59-A-124*

Oliver Dam hydro plant electrical design, *R J Kelly, Georgia Power Co*

Georgia Power Company's new Oliver Dam Hydroelectric Station has a capability of 60,000 kw. This is made up of one 8500-hp and three 25,400-hp hydraulic turbines. Concrete gravity dam is approximately 2000-ft long and 80-ft high above the river bed.

All turbines are fixed-blade type rated at 68-ft head. Larger machines run at 150 rpm and the 8500-hp unit runs at 257 rpm. Generator operating voltage is 7600 which is the highest permissible for 6900-v class machines. 22,500-kva and 7500-kva 0.80-pf generators have direct-connected main and pilot exciter with provisions for permanent-magnet generators at top of each unit.

Station is arranged for automatic remote operation from Georgia Power's Bartlett Ferry Hydro Plant located about 14-mi upstream. Hence new station has no centralized control-room facilities. *AIEE 59-497*

A new runaway-speed limiter for kaplan turbines, *C H Voaden, Allis-Chalmers Manufacturing Company*

Runaway speed in adjustable-blade kaplan hydraulic turbines varies with blade angle. At low blade angles, runaway speed is 2.5 to 3.0 times rated speed. At high angles this fac-

accuracy

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Choose your Ashcroft Duragauges made of components best suited to your needs. Eight Bourdon tube materials are available. Movement of stainless steel with nylon bearings and pinion gear for longest wear. Case materials: special aluminum alloy or tough phenol plastic.

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Correct installation requires free condensate drainage on the discharge side. A cooling leg of at least three feet is a necessity to cool condensate, since thermostatic traps operate on temperature differential. The strainer should be installed in a down position to avoid freezes which could break the strainer body.

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Technical briefs

Begins on page 96

tor is reduced to 1.85 to 2.25. Higher runaway speeds impose severe design penalties but any means taken to reduce them must be completely reliable.

Method of limiting runaway speeds outlined provides for quickly freeing blades from normal control through centrifugally operated bypass around control piston. Method goes into operation whenever there is indication that speed is out of control—triggered by approximately 40% overspeed. Blade-pivot locations are set so that hydraulic unbalance will automatically increase blade angles once they are free from control.

Lab and field tests show effectiveness of arrangement in limiting runaway speeds. Permanent modification has been made in several installations with satisfactory results. Author suggests that all future kaplan hydraulic turbines incorporate this feature. *ASME 59-A-103*

Bearing design

Bearing oil-ring performance, *D C Lemmon and E R Booser, General Electric Company*

Oil rings have been used in bearing lubrication for over 100 years. Originally applied on low-speed equipment, they are now in operation at speeds as high as 4000 rpm.

To study their operating characteristics at various speeds, two test rigs were specially designed — one for large and one for small journal and ring sizes. On a few of the smaller sizes tests were run as high as 7000 rpm. Five factors affected oil-film delivery: (1) depth of immersion (2) oil viscosity (3) use of guides and scrapers (4) materials of construction and (5) out-of-roundness. Three distinct ring-speed vs journal-speed relationships were found to exist: (1) no-slip operation (2) partial-film drive and (3) full-film drive.

Test results are presented for both large and small rings. Various formulas developed cover ring speeds and oil delivery. *ASME 59-Lub-5*

continued

For more facts circle 245 on Reader Service card, p 109

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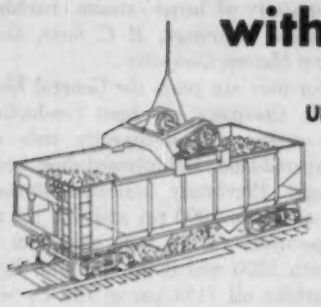
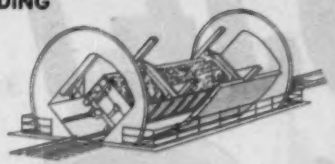
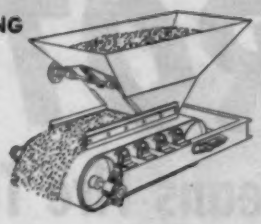


CAR SHAKERS are ideal for small or moderate capacity unloading. Low-frequency vibration is easy on cars . . . positive action cleans hopper-bottom cars fast.



ROTARY DUMPERS unload all types of open-top cars up to ninety-ton capacity. Cars are turned upside down and contents dumped in less than a minute.

FEEDING



FEEDERS for every use are available from Link-Belt. All assure uniformly controlled feed. Broad line includes belt, apron, screw and vibrating types.

STORING AND RECLAIMING — Link-Belt has all equipment necessary for fast, efficient storage and reclaiming . . . hoppers, feeders, conveyors. Can design, equip and install systems for any capacity. At small power plants, elevators and silos provide low-cost storage.

CENTRAL STATION OR SMALL BOILER HOUSE—Link-Belt has equipment for *every* coal handling job. We can furnish components or complete systems to match any capacity, any layout. And, if desired, we will work with your engineers and consultants from planning to erection of your system.

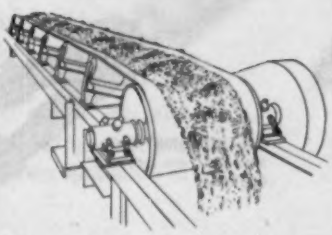
For full details, contact your nearest Link-Belt office. Ask for Book 2410—44 pages of coal handling equipment.

15,302

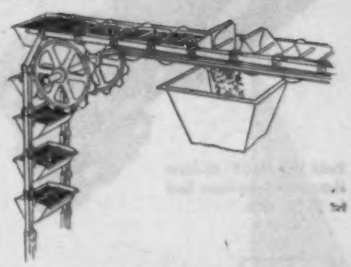
LINK-BELT

COAL HANDLING EQUIPMENT

DISTRIBUTING

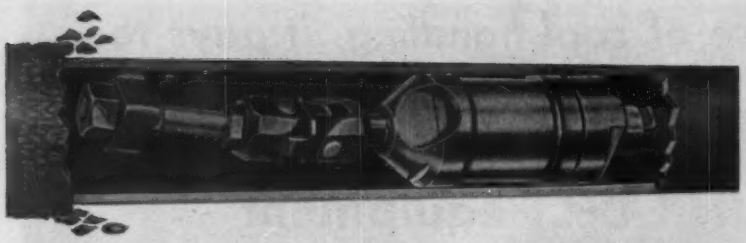


BELT CONVEYORS move large tonnages at low cost—stock out, reclaim, distribute. Link-Belt also builds a full line of idlers, trippers, etc.



PECK CARRIERS elevate and convey in a continuous flow without transfers . . . can travel many combinations of vertical, horizontal, inclined paths.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.



ROTOJET®

Cleans Fire Tubes ▸▸▸▸▸▸ FAST ◂◂◂◂◂◂

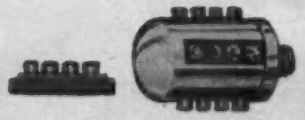
INSIDE and OUTSIDE

You can now clean fire tubes inside as well as outside faster with a new Rotojet. The new Rotojet is the most powerful tube cleaner we ever built. It won't stall at low speeds caused by heavy loads. Roto expanding heads and brushes thoroughly clean soot scale inside tubes. A Roto vibrating head (illustrated above) knocks off water scale adhering on the outside.

Try the new Rotojet, and no other tube cleaner will ever satisfy you.

Economical Roto Brushes

Roto expanding brushes and heads have separately replaceable wearing elements. These inexpensive parts save time, money, and critical materials. Send for details.



Roto expanding brush, showing a replaceable brush element. Brings down tube cleaning cost. Maintains high cleaning efficiency.

Roto solid wire brush.

Model 5525 ROTOJET Air-driven Motor with swing-frame head for 3" O.D. tubes.

Model 5505 ROTOJET Air-driven Motor with 2-arm head for 2" O.D. tubes.

ELLIOTT COMPANY – ROTO PLANT
Tube Cleaner Specialists Since 1910
153 Sussex Avenue, Newark, N. J.

Technical briefs

Begins on page 96

Recent improvements in load capacity of large-steam-turbine thrust bearings, *H C Bahr, General Electric Company*

For over six years the General Electric Company has been conducting a series of load-capacity tests on tapered-land and pivoted-shoe bearings. Previously indicated ultimate loads were 1000 psi and 700 psi respectively. Load tests were run at both 1800 and 3600 rpm and light turbine oil (154 ssu at 100 F) was used.

In both bearing types, copper instead of steel backing increased ultimate load capacities, due to the higher heat conductivity of copper. Pivoted-shoe bearing capacities increased to 1210-1560 psi, and tapered-land bearings went as high as 1300-2100 psi. At loads in the 800-900 psi range, operating temperatures were reduced as much as 25 F compared to similar bearings with steel backing. *ASME 59-A-139*

To obtain complete text

Material for these abstracts comes from the following sources. Order complete paper from source, not POWER.

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For more facts circle 247 on Reader Service card, p 109

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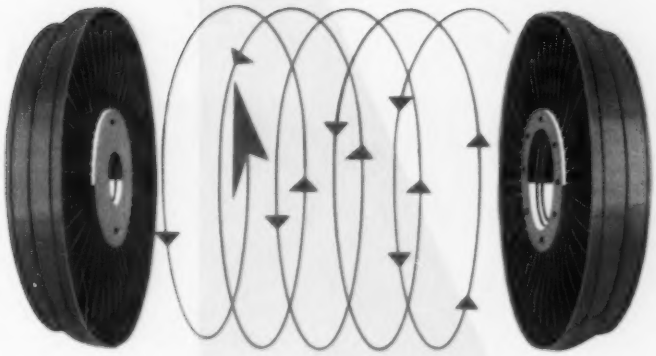


New from American-Standard
Industrial Division

Power-Lift† for Power Plants

cuts auxiliary demand with Gýrol® Fluid Drive

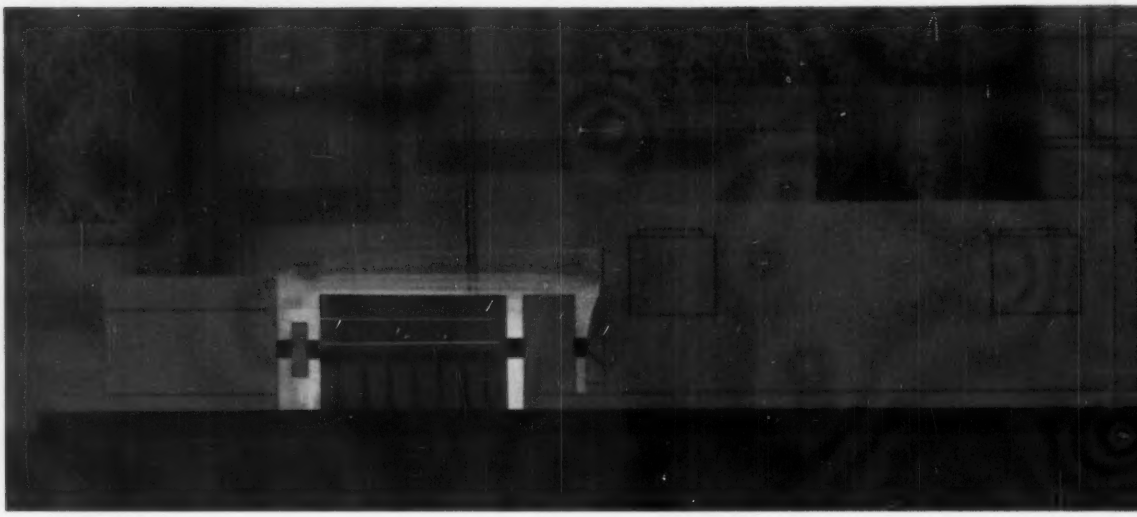
Power-Lift is a timely new concept of coordinated products and services from American-Standard Industrial Division. Its purpose is to help you raise overall efficiency in your plant by offering *products* that are proved in the field and designed, engineered, and manufactured to a uniform standard of quality and performance . . . with *service* by product specialists in every principal city.

← **LIFT THE FLAP** *and see how Gýrol Fluid Drives provide cost-saving benefits for fans and boiler feed pumps . . .*

†Service-mark of American-Standard

American-Standard Industrial Division POWER-LIFT IN ACTION

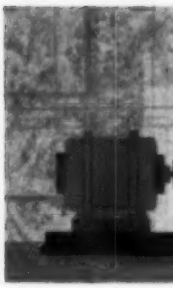
Gýrol® Fluid Drive
proved record of f



On-the-shaft Fluid Drive applications offer multiple savings. In addition to the well-known savings which adjustable speed offers, main shaft driven pumps eliminate costly electrical accessories necessary for motor driven pumps. Auxiliary demands are reduced, so more power can be released to consumer lines.

"On-the-Shaft" Gýrol Fluid Drives
installed, or to be installed,
for the following public utilities:

Consolidated Edison of New York, Inc.
Public Service Electric & Gas Co.
Pacific Gas & Electric Co.
Louisiana Power & Light Co.
Southern California Edison Co.
Consumers Power Co.
Commonwealth Edison Co.



On motor d
advantages of Fl
of installations ov
adjustable speed
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of high pressure
Fluid Drive prov
rating to shutoff

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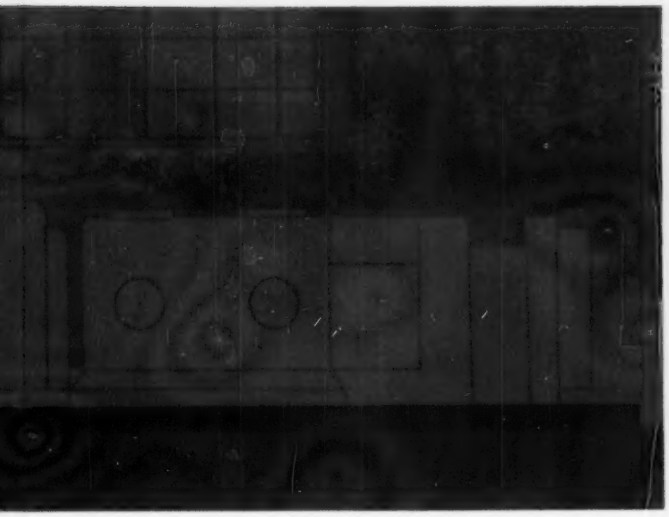
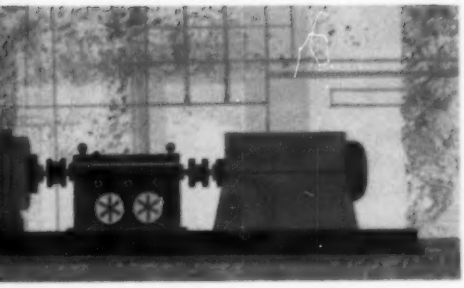
field experience and reliability

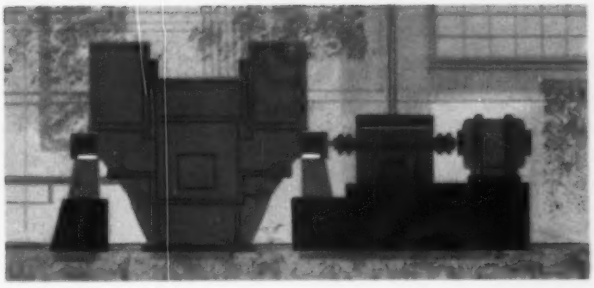


Today more than 4-million horsepower are being driven through Gýrol Fluid Drives in public utilities, industrial power plants, and on industrial machinery of all types. Such widespread acceptance could only come from proved performance in the field.

In power plant applications, not only does Gýrol Fluid Drive's stepless, shockless, adjustable speed pay off in better control, lower maintenance costs and reduced noise levels, but it also provides substantial power savings through lower horsepower requirements.



or driven boiler feed pumps the of Fluid Drive have been proved in hundreds ons over the past 20 years. Through Fluid Drive, peed savings in pump horsepower are obtained ire actual operating range. In many cases elimid water regulating valves and lower initial costs sure heaters, piping and fittings are effected. provides fast, accurate control from full pump utoff. Operators like this full-range flexibility.



Fluid Drive on Mechanical Draft Fans. Present day boilers are demanding larger fans requiring higher horsepower and higher speed motors. Problems of high fan WR^2 starting, of fan noise and of fan control are of increasing concern. Fluid Drive provides a better means of driving and controlling today's mechanical draft fans. Fluid Drive can divorce fan from motor for starting. Through adjustable speed Fluid Drive can lower fan noise, reduce fan wear, and save fan horsepower.

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Talk over your requirements with an American-Standard* Industrial Division product specialist. You'll find him well prepared and experienced—frequently able to base equipment recommendations upon precedents of proved success. And, in many instances, our comprehensive standardization paves the way to savings in time and cost. Offices in all principal cities. AMERICAN-STANDARD INDUSTRIAL DIVISION, DETROIT 32, MICHIGAN. IN CANADA: AMERICAN-STANDARD PRODUCTS (CANADA) LIMITED, TORONTO, ONTARIO. EXPORT DIVISION, AMERICAN-STANDARD, NEW YORK CITY.

SURFACE CONDENSERS

Designed to service the largest of today's and tomorrow's steam turbines. Low bundle entrance velocity; liberal steam transportation lanes; moisture impingement grids to extend tube life; expansion diaphragms; effective de-aeration and many other features created during 40 years of surface condenser development and research.

MECHANICAL DRAFT FANS

Complete range of sizes and types for forced draft, induced draft, gas recirculating, and primary air fan applications. Designed to meet rigid requirements of modern power plants where maximum pounds of steam are produced daily at peak efficiency. Airfoil, forward curved, backwardly inclined, radial, radial tip blades.

FEEDWATER HEATERS

Design incorporates unique new High Pressure closure. Maintenance is simplified with only four major parts. Exceptionally high safety factor built into all units—more than double ASME Code requirements. Temperature stresses from start-ups or load changes virtually non-existent.

HEAT EXCHANGERS

Designed and built with thoroughness and precision. Standard or specially engineered units for virtually all conditions and applications, including high pressure-high temperature exchangers, compressor inter- and after-coolers, fuel oil heaters, blow-down exchangers, and many others.

GYROL® FLUID DRIVE

Provides stepless adjustable speed control for fans and boiler feed pumps. Performance, power savings, and reliability proved in the field. Units for motor driven boiler feed pumps or for "on-the-shaft" duty on main turbine generator. Drives are available for fan and pump duties for all boiler sizes.

DUST AND FLY ASH COLLECTORS

Type "D" Dust Collector: mechanical "cyclone-type" collector. Series 342 Dust Collector: uses "cyclone" principle, with individual tubes which permit flexibility in design to fit plant layout. Series 361 Dust Collector: combines primary and secondary systems for high efficiency fly ash recovery.

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- **Study New Equipment** described in this issue starting on p 126. Circle numbers on card corresponding to items listed
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New free literature

MECHANICAL POWER TRANSMISSION

101 **V-belt drive** cuts overall drive dimensions in half—details in 36-p booklet. Drive-selection tables for stock and nonstock sheaves, hp, specs and installation instructions are given. T B Wood's Sons Company

102 **Gearbelt drives** are topic of 58-p bulletin. Info on installation, engineering, drive combinations and pulleys is included. Browning Manufacturing Co

103 **Timing-belt drives** are subject of catalog DTE-1. Selection, design, installation, operation and maintenance info is given. R & J Dick Company, Inc

104 **Adjustable-speed drives**, eddy-current coupling models, are described in 12-p bulletin GEA-6885. Units have 5- to 100-hp rating. Dimension, rating and data charts are included. General Electric Company

105 **Vertical motor reducers** and in-line reducers are topics of 28-p catalog Mr-58. Units have eight housing sizes for applications up to 125 hp, output speeds of 9 to 420 rpm. Philadelphia Gear Corporation

106 **Variable-speed pulleys** are topic of 24-p bulletin HL-60. Discussion of operating principles and proper selection is included. Hi-Lo Manufacturing Co

107 **Variable-speed sheave** for standard V-belts with stationary control is detailed in 8-p bulletin 6102. Exploded view shows and labels components. Construction, installation data are covered. T B Wood's Sons Co

108 **Tapered roller pillow blocks** are detailed in 4-p bulletin BU-102-A. Units are malleable. Browning Manufacturing Co

109 **Spherical roller bearings** are announced in 16-p bulletin 113, and combustion is given. Walter Engineering info is given. Hoover Ball and Bearing Co

110 **Spherical roller bearings** are detailed in 52-p booklet 2760. Design features, selection data, formulas, diagrams, photos and charts are included. Link-Belt Co

111 **Flexible coupling** engineering catalog has 50 pp, numerous photos, charts and diagrams describing firm's products. Booklet 60 is both selection and reference guide. Applications of new styles, couplings for special conditions are also shown. The Thomas Flexible Coupling Co

PUMPS

112 **Turbine pump motors** for outdoor service are topic of brochure F-1953. Principles of design are explained, new design features illustrated. U.S. Electrical Motors Inc

113 **Packaged pump** and heater sets for fuel oil are described in 4-p bulletin 15. Data on units as controls insuring atomization H Eagan Co, Inc

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114 **Pump - tank combination** for chemical - solution feeding and economical boiler-water treatment is announced in 2-p reference 7253.20-1. B-I-F Industries, Inc

115 **Metering pump,** electrically driven, positive-displacement reciprocating, plunger type handling 0.65 to 2025 gal per hr is introduced in 12 - p catalog 420.200. Wallace & Tiernan Inc

116 **Pump for metering** or proportioning with pump-plunger positioning accuracy within 0.002 in. is described, with operating principles explained in 4-p brochure P-21. Associated Control Equipment, Inc

117 **High-head canned pumps, 2-stage** type, for heads up to 600 ft, temperatures to 850 F and pressures to 3500 psi are described in 4-p bulletin 1080. Fostoria Corp, Chempump Div

118 **High-vacuum pumps** using the Roots principle are described in 16-p well - illustrated bulletin S-20. Specs, operational info given. Consolidated Vacuum Corp

119 **Composite 3-color curve** showing firm's sealless leakproof pump ranges is offered. Fostoria Corp, Chempump Division

120 **Condensation pump** line of firm is detailed in 12-p new-product bulletin CP-600. American Air Filter Company, Inc

121 **Controlled - volume pump,** trap and filter for removing concentrated sulfuric acid sludge are detailed in bulletins 1153-C and 459. Milton Roy Co

SAFETY EQUIPMENT

122 **Interior fire-fighting** equipment catalog S-62 has 28 pp, contains up-to-date engineering facts, specs. Hints for well-engineered interior fire-control systems are given. The Fyr-Fyter Company

123 **Fire-extinguishing systems** and equipment are described in folio 1-1. Suggested explanations of causes of large-loss fires included. Chemetron Corp, Cardox Div

124 **Fire equipment,** firm's complete line, is outlined in 20-p annual catalog. Ansul Chemical Co

125 **Portable fire pump** is topic of new - product bulletin. Lightweight pump can be carried by one man. Goodyear Pumps Inc

STEAM GENERATION

126 **Packaged boilers** are detailed in 8-p bulletin. H-t equipment for heating and process loads is also featured. Specs, ratings and dimensions of firm's line are included. Cleaver-Brooks Co

127 **Automatic firetube boiler,** 15- to 600 - hp packaged boilers and comparative boiler - installation costs are featured in bulletin Be-400 and bid-tabulation form. Overall dimensions and empty weights of 15- to 250-psi models are given. Boiler Engineering & Supply Co, Inc, Continental Boiler Div

continued

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NEW FREE LITERATURE continued.....circle key numbers, page 109, for your copies

128 **Watertube boilers,** 2-drum, oil, gas or coal fired are featured in 20-p new-product catalog SB-57R. Erie City Iron Works

129 **Flyash-control system,** "wet water" type, is explained in 4-p folder 66B. Deynor Corp

130 **Automatic firing equipment** is detailed in 12-p well-illustrated booklet 6260. Iron Fireman Manufacturing Company

PRIME MOVERS

131 **V type 4-cycle engines,** which operate on diesel, Duafuel or spark-ignition gas are topic of 18-p bulletin 262. Illustrated applications, cross-section drawings explain engines' operation. Nordberg Mfg Co

132 **Power-recovery gas-turbine** compressors designed to expand waste process gases to 1250 F are described in 12-p booklet P-10. Elliott Co

PIPING, VALVES FITTINGS AND SPECIALTIES

133 **Gate valve** with nylon disk, temperature-control valve are featured in spec sheets JNP-2, chart 76. OPW-Jordan

134 **Pressure-reducing** and regulating valves are detailed in spec sheet. A W Cash Valve Mfg Co

135 **Midget 3-way solenoid valve** with quick exhaust is featured in spec sheet 8317. Automatic Switch Co

136 **Filtration-plant valves** are described in 8-p bulletin W-18. Units are applicable for both high and low pressures. Golden-Anderson Valve Specialty Co

137 **Valves** which can be used for pressure reduction, relief or as pump governors with steam, oil, water, gas or air are topic of 4-p bulletin. Atlas Valve Co

138 **Rubber-seat butterfly valve** is subject of brochure 10K. Price list, specs, selection info make this comprehensive catalog a working tool for engineers. Henry Pratt Company

139 **Firm's line of valves** is presented with ordering info in new booklet. W M Kindel, Circle Seal Products Company, Inc

140 **Valve for abrasive slurries** is topic of spec sheet 159-A. United Conveyor Corp

141 **Two-way valves for air,** oil, water, gas or chemicals with psi rating to 500 are topic in 8-p bulletin 91022. Airmatic Valve, Inc

142 **Relief valve for regulating** discharge pressure of oil or water, constant-speed pumps is featured in bulletin. Atlas Valve Co

143 **Check valves,** firm's complete line, are presented in 20-p bulle-

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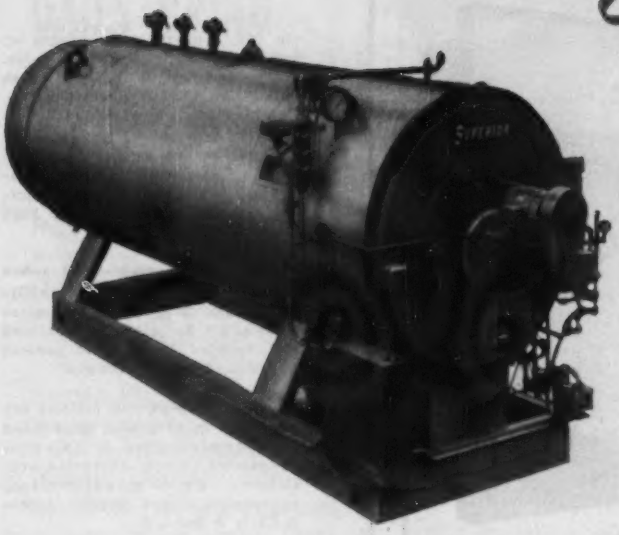


This is the PACKAGED BOILER

that meets ***ALL*** *the "specs"*

BOILER SPECIFICATIONS

Undivided responsibility	✓
5 sq. ft. of heating surface per boiler horsepower	✓
Built-in induced draft	✓
4-pass, down-draft design	✓
Burn oil or gas, or both	✓
Fully automatic operation	✓
Dependable rotary burner	✓
Insulated and jacketed	✓
80% thermal efficiency guaranteed	✓
Factory-fire-tested	✓

Many packaged boilers will meet some of the specifications listed here. Superior Packaged Boilers meet them ALL. Today, more and more packaged boilers are being purchased on the specifications of architects and consulting engineers. Those consulting engineers are demanding that packaged boilers "measure up" to design and performance standards which assure buyers both operating economy and long-lived dependability.

Superior Packaged Boilers . . . built to the highest standards in the industry . . . meet the most exacting "specs", and usually exceed them. That is why Superior Packaged Boilers are so often recommended and so quickly approved by experienced consulting engineers.

In addition to the Type C, illustrated, Superior manufactures both fire-tube and water-tube boilers in a wide range of sizes which makes it the most complete line of fully packaged boilers available. If you will indicate the capacity in which you are interested, we will be happy to assist in the unbiased selection of boiler equipment suited to your specific operations.

Write today for bulletin 11C.

Specialists in PACKAGED BOILERS... exclusively

SUPERIOR COMBUSTION INDUSTRIES, INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

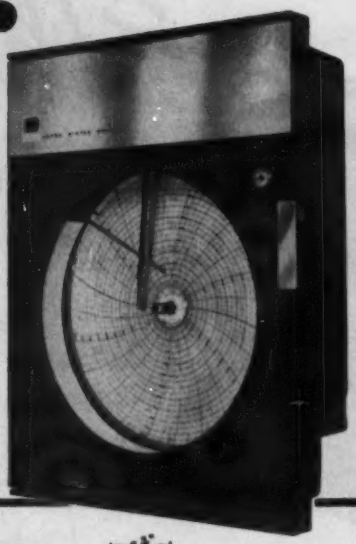
SUPERIOR
PACKAGED BOILERS

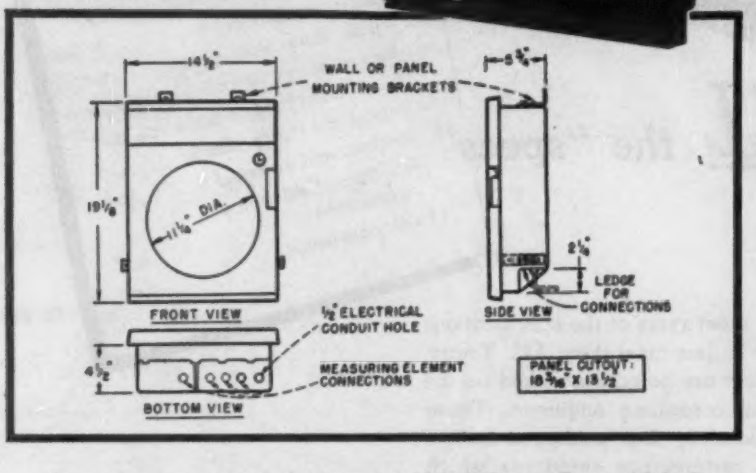
For more facts circle 249 on Reader Service card, p 109

NEW!

MODERNIZED RECORDER HAS UNIVERSAL CASE for all mountings and connections

Also features largest chart opening in the industry





Now, the time-proved, field-proved United States Gauge 12-inch pressure and temperature recorder with completely new, trim, practical exterior design . . . including many important features found only on higher priced instruments. Now, outside and in . . . the USG Recorder offers still more quality, performance and advantages at a money-saving price.

Recessed back. Connections can enter case vertically or horizontally without special mounting.

Largest chart opening in the industry. 11¼-in. diameter for better visibility of chart. Shatterproof glass or blind door optional.

Removable door. New hinge pins permit easy removal of door for access to instrument.

Light weight. Cast aluminum case. Steel back plate provides rigid reference surface for components, prevents recording errors due to stress on case.

Modern design. Enhances modern equipment. Stainless steel escutcheon can be embossed with equipment manufacturer's name.

Fluorescent lighting optional. Ends overheating of case. Improved door skirt increases light on chart.

Dust ledge. Top and bottom. Protects door from dust, moisture.

Ball pivoted pen movements. Exclusive. For 1, 2, 3 or 4 pens.

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Free literature

Begins on page 110

tin 600. Charts show effects of engineered-spring-closing valve. Specs on various models, sizes rated 125 to 1500 psi are given. Combination Pump Valve Co

144 **Pipe-alignment guide** for movement caused by temperature-change expanding and contracting is offered. The Align-O Pipe Guide Co

145 **Fabrication of tight-bend tubes** is discussed in 8-p booklet AEB-25. Aluminum, steel, stainless steel and other alloy fabrications are treated with cold-process method. Aeroquip Corp

146 **Ductile iron pipe** and fittings are discussed in 20-p well-illustrated and comprehensive brochure. Properties, specs, corrosion-resistance and manufacturing-process data are given. James B Clow & Sons, Inc

147 **Standardization of alloy steels** for tubing applications is topic of folder TDC-193. Steels are broken into two categories to simplify matching tubes to specific jobs. Through-hardening and case-hardening are detailed. The Babcock & Wilcox Company, Tubular Products Div

148 **Hose and hose fittings** are topic of 8-p catalog. Includes spec tables on reusable hose fittings, assemblies, adapters, single and double wire-braid hose. Lenz Co

149 **Flexible connectors** are described in catalog sheet. Pennsylvania Flexible Metallic Tubing Co

150 **Molded packings,** V type, are featured in 8-p bulletin GTR-759. Engineering data includes formulas for computing stack heights. Greene, Tweed & Co

151 **Seal** which operates on balanced fluid pressure alone is introduced in new-product bulletin. A W Chesterton Company

152 **Sealing nuts** for eliminating leaks on pipe threads are detailed in 2-p bulletin 6170. The Weatherhead Company

153 **Self-sealing fasteners,** switch and shaft seals are illustrated in 16-p general catalog 359A. Tabular data, specs and engineering drawings aid explanation. A P M Corporation

154 **Corrosive shaft seal** made from Teflon is described in new-product bulletin. Sizes range from ⅝ to 3 in. Crane Packing Co

WATER TREATMENT

155 **Boiler-gasket-leakage** causes and problems in use of sewage-

DAILY GRIND ALWAYS UNIFORM with Pennsylvania Reversible Hammermills

Regardless of condition of coal or amount of hammer wear—Pennsylvania Hammermills are noted for producing a highly uniform product day after day.

Basic design and simple adjustments available to the operator on the spot make this possible.

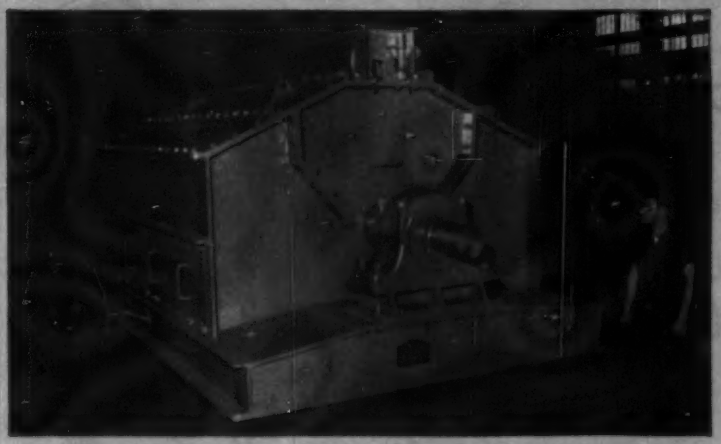
Pin point adjustments of cage-hammer clearance (by ratchet wrench and worm gear assembly) compensate for hammer wear or coal condition.

Crushing action keeps fines to minimum. Free air impact crushing in upper zone prepares coal so there is little dredging of hammers through oversize in cage-bar zone. Results—uniform grinds day after day.

DOUBLE CRUSHING AREA: DOUBLE CAGE, BLOCK AND HAMMER LIFE

No other crushers give you so much more for your money. Pennsylvania Reversible Hammermills give double the crushing area—double the life of cage bars, breaker blocks and hammers. A flick of the switch; rotor is reversed and you are using a duplicate mill.

What's more, hammers need never be hand turned, and wear is kept uniform.



• Pennsylvania Reversible Hammermill for preparing bituminous coal for exact specifications of cyclone burner bin system, ready for shipment to large southern power plant.

With adjustable cage assemblies, hammers can be worn much further while keeping grind uniform—with no falling off of tonnage.

FREE BULLETIN

Bulletin 1040, giving a full description of the design, construction features, operation and maintenance of Pennsylvania Reversible Hammermills, can prove profitable reading for you. Write for a copy today.

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DOUBLE DIVIDEND! Pennsylvania Bradford Breaker cleans coal as it crushes

Famous Pennsylvania Bradford Breakers not only crush and size run-of-mine coal—they automatically remove and discharge tramp iron and other refuse. This is just one of many features giving Pennsylvania world leadership for this type of crusher. Over 100 million tons of coal annually are prepared by Pennsylvania Bradfords in power plants everywhere.

For complete information, write and ask for Bulletin 3009.

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Over 50 years concentrated experience in all types of material reduction makes Pennsylvania your best source of crushers and engineering advice and service. Call on Pennsylvania with your next crushing problem. Representatives from coast-to-coast.

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BATH-BUILT

INSIDE STORY — HEV-E-OIL burner is the *only* commercial-industrial burner that successfully applies the principle of low-pressure air atomization of heavy fuels *inside the nozzle.*

HEV-E-OIL BURNERS

HEV-E-OIL commercial-industrial burners operate on the principle of low-pressure air atomization and furnish *all the air necessary for complete combustion.* This assures efficient, economical operation — perfect fire control regardless of weather or draft conditions. And HEV-E-OIL burners offer you *double savings!* They are especially engineered to make use of inexpensive heavy oils — number 4 and 5. Number 6 or Bunker C in larger models. Available from 5 to 150 gph.

HEV-E-DUTY POWER GAS BURNERS meter air in perfect proportion to the amount of gas used — high efficiency regardless of uncertain stack draft. HEV-E-DUTY COMBINATION GAS & OIL BURNERS offer fuel-proof changeover from gas to oil — in most models just a flip of a switch makes the change. Capacities from 720,000 to 21,000,000 Btu.

These fine burners offer many other sure-fire features! Complete package! Low-fire start! Fire tested! Completely automatic! Meet all codes! Safe, electronic controls! Simple installation! Send for free bulletin. Write Industrial Combustion, Inc., 4507 N. Oakland Ave., Dept. P-30, Milwaukee 11, Wis.

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Free literature

Begins on page 110

plant effluent for boiler and cooling purposes are discussed in technical papers 138, 139. Betz Laboratories, Inc

156 **Mixed-bed demineralizer** with capacities from 2100 to 13,200 gph is topic of brochure. Cochrane Corporation

157 **Packaged mixed-bed demineralizers** designed for process-water applications operate to 13,200 gph —details in 4-p bulletin 5819. Cochrane Corp

158 **Structural plastics** for water-intake gates are described in 12-p brochure. Specs, cutaways included. Studebaker-Packard Corp, CTL Div

159 **Modern approach** to cooling-water treatment is topic of new water-conditioning data sheet. Betz Laboratories

160 **High-rate clarifier** and softener cost estimations are discussed in technical reprint T-171. Graver Water Conditioning Company

161 **Sodium zeolite water-softening** manual 4520 describes process, gives info on selecting and sizing equipment. Cochrane Corp

162 **High-flow-rate clarifier** with suspended-sludge design is featured in 8-p bulletin CL 158. Operating features, types of clarifiers in firm's line are described. Illinois Water Treatment Company

163 **Instrumentation** for water-treatment plants is topic of reprint. Topics such as effluent control, conductivity, sodium zeolite systems and recent developments in field are discussed. Graver Water Conditioning Company

164 **Concentric** and flat-leaf vacuum filters for industrial process water are topic of 4-p bulletin 1860.20-2. B-I-F Industries, Inc

165 **Desilicizer feedwater process** is described in reprint 124. Process reduces silica in boiler feed to less than 0.5 ppm. Cochrane Corporation

166 **Storage water heater,** indirect gas-fired type, is topic of 4-p bulletin 4. The Patterson-Kelley Company, Inc

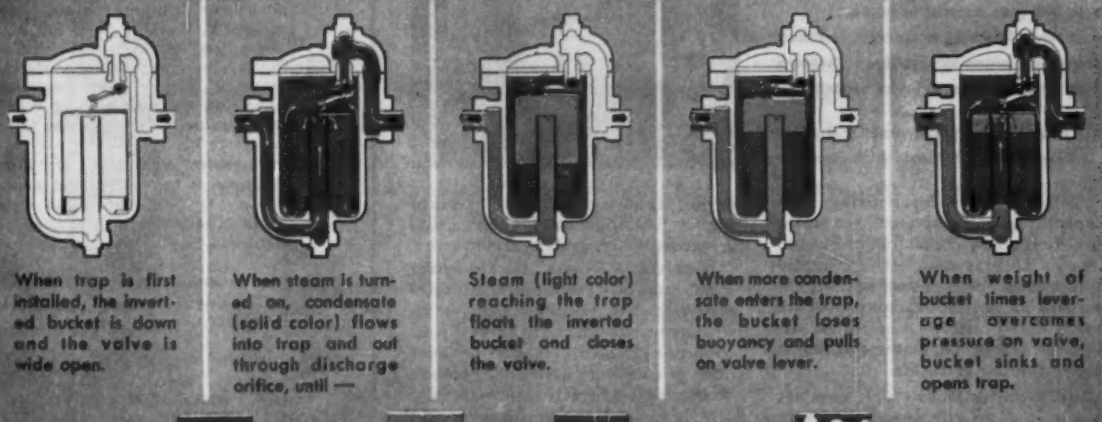
167 **Priming and foaming** in low-pressure heating boilers are discussed briefly in bulletin 597. Water Service Laboratories, Inc

AIR CONDITIONING, HEATING AND VENTILATION

168 **Furnace** for production heating is topic of 4-p bulletin 7. Sunbeam Equipment Corp

continued

This simple trap operating principle provides the efficiency, dependability and freedom from maintenance necessary for the most profitable use of steam



When trap is first installed, the inverted bucket is down and the valve is wide open.

When steam is turned on, condensate (solid color) flows into trap and out through discharge orifice, until —

Steam (light color) reaching the trap floats the inverted bucket and closes the valve.

When more condensate enters the trap, the bucket loses buoyancy and pulls on valve lever.

When weight of bucket times leverage overcomes pressure on valve, bucket sinks and opens trap.

Key: condensate steam steam bubbles air bubbles

ARMSTRONG INVERTED BUCKET STEAM TRAPS

are designed and made to give you these big benefits:

Armstrong Traps, the first inverted bucket steam traps, now represent the most advanced development of this time-proven principle. They provide all the advantages necessary for efficient, economical condensate drainage from virtually all types of steam using equipment.

1. *No steam loss* – Steam never reaches the orifice even when there is no condensate load.
2. *Automatic air elimination* – Vent in trap bucket passes air and other non-condensibles through to be discharged with condensate.
3. *No cooling leg required* – Condensate is discharged at steam temperature as fast as it reaches the trap because trap operates on difference in density between steam and water not on temperature.
4. *Operates on any back pressure* – Failure of one trap in system will not cause others to open because high back pressure does not affect an Armstrong trap other than to reduce capacity. As long as there is a pressure differential across the orifice the trap will close on steam and open for condensate.
5. *Unaffected by ordinary dirt* — Swirling action of condensate keeps dirt in suspension until discharged with condensate, prevents it from lodging in valve.
6. *Completely dependable* — Proved design plus the use of all stainless steel working parts assure continuity of service and length of service unmatched by any other trap.
7. *Big capacity in a small, economical package* — Armstrong design gives you the highest practical capacity for any given pressure. And remember, Armstrong capacity ratings are based on *hot* condensate at the *working pressure differential* stated, not on theoretical orifice capacities.

Further information on these advantages plus much additional information is given in the 48 page Armstrong Steam Trap Book. Ask your local Armstrong Representative or write direct.

860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

ARMSTRONG MACHINE WORKS

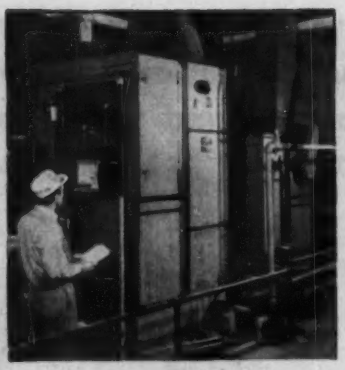
8123 Maple Street Three Rivers, Michigan

See our Catalog in Sweet's Plant Engineering File.

For more facts circle 253 on Reader Service card, p 109

DRY and CLEAN AIR at the RIGHT TEMPERATURE

- to control your product quality
- to protect a critical operation
- to protect apparatus from moisture damage
- to DRY your material or product
- to control packing or storage conditions
- to assure precision in testing or research
- to increase air conditioning capacity



Air Condition by the NIAGARA Method Using HYGROL Liquid Absorbent

This compact method, giving high capacity in small space, removes moisture from air by contact with a liquid in a small spray chamber. The liquid spray contact temperature and the absorbent concentration, factors that are easily and positively controlled, determine exactly the amount of moisture remaining in the air.

Most effective because... it removes moisture as a separate function from cooling or heating and so gives a precise result, and always. Niagara machines using liquid contact means of drying air have given over 20 years of service. The apparatus is simple, parts are accessible, controls are trustworthy.

Most reliable because...the absorbent is continuously reconcentrated automatically. No moisture-sensitive instruments are required to control your conditions... no solids, salts or solutions of solids are used and there are no corrosive or reactive substances.

Most flexible because...you can obtain any condition at will and hold it as long as you wish in either continuous production, testing or storage.

Write for Bulletins 112 and 131 and complete information on your air conditioning problem.

NIAGARA BLOWER COMPANY

Dept. P-3, 405 Lexington Ave., New York 17, N.Y.

Niagara District Engineers in Principal Cities of U. S. and Canada

For more facts circle 254 on Reader Service card, p 109

WELD IT "IN THE LINE" AND FORGET IT!

- Inlet Pressure up to 6000 PSI and Pressure Drops to 550 PSI
- Temperatures from −300°F to +2000°F
- Equal Percentage Flow for Good Control

Sizes range from 1" to 24". Available in any desired pipe schedule. Body and disc can be carbon steel or any ASTM castable alloy. No gaskets or flanges required. Available for all types of power actuators.

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WELD-END

BUTTERFLY VALVES

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FISHER GOVERNOR COMPANY

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CONTINENTAL

FISHER Controls

Free literature

Begins on page 110

169 **Thermal insulation catalog** is for all types of requirements in applications ranging from −400 to 3000 F. Catalog 37-D has sections on heating, air conditioning, refrigeration, insulating firebrick and refractories, finishes and weatherproofing materials. Johns-Manville Sales Corp.

170 **Dust-topics pamphlet** discusses methods of collecting and measuring aerosols and dusts from ducts and stacks. Gelman Instrument Company

171 **Porous stainless-steel filters** are detailed with specs in 4-p bulletin M-212A. Pall Corp

172 **Unit air filters,** permanent and washable type, are discussed in 12-p well-illustrated bulletin 207. Explanations of filter maintenance methods and equipment are given. American Air Filter Company, Inc

173 **Dust collector** with large-dia tubes is topic of 4-p bulletin 10-26-59. Dustex Corp

174 **Dehydration units** for air, gases, liquids are described in 4-p bulletin 160-1. J F Pritchard & Co

METALS AND MATERIALS

175 **Silicone fluid,** electrical grade, for use as dielectric fluid, lubricant, heat-transfer medium or mechanical fluid is detailed with price list in product data sheet SF-85 (50). General Electric Co

176 **Steel castings** are topic of bulletins 32, 39. Tabular summary of engineering properties of various types of castings is included. Meehanite Metal Corporation

177 **Industrial plastics** are discussed in 16-p booklet which gives info on firm's products and services. Properties, applications and availabilities of various plastics are outlined. The Polymer Corp

178 **Steel blast-cleaning abrasives** are outlined in 20-p brochure. Graphs show features. Pangborn Corporation

COMPRESSORS

179 **Portable rotary compressor** delivering 135 cfm of air at 100 psi at slowest speed—1600 rpm—is detailed in 4-p bulletin. Westinghouse Air Brake Company, Le Roi Div

180 **Turbocharged,** gas-engine-driven compressor is described and illustrated in bulletin 179. Specs and dimensions of models ranging from 660 to 1320 bhp are included. Clark Bros Company

continued

YOU CAN DEPEND ON WOLVERINE CONDENSER TUBE—

IT'S MADE THE TUBEMANSHIP WAY

From Wolverine Tube's years of experience in the heat transfer field has come tubing designed to meet *all* needs.

For example, when retubing surface condensers or feed water heaters, power engineers have a complete range of Wolverine prime surface tubing from which to select exactly the right copper alloy required to meet their operating conditions.

On the other hand, for such specialized applications as combustion air preheaters they can specify high-finned Wolverine Trufin Type H/A—the integrally finned condenser tube that has an outside to inside surface ratio of from approximately 8:1 to 16:1.

Providing the right tube for all types of applications is, however, but one of the many benefits Tubemanship brings to Wolverine customers. Thanks to Wolverine Tubemanship you are also assured of tubing that is backed by constant research, sound engineering and held to rigid specifications by statistical quality control.

Next time you order condenser tubing specify Wolverine—be sure of tubing manufactured the Tubemanship way. Write for complete information.

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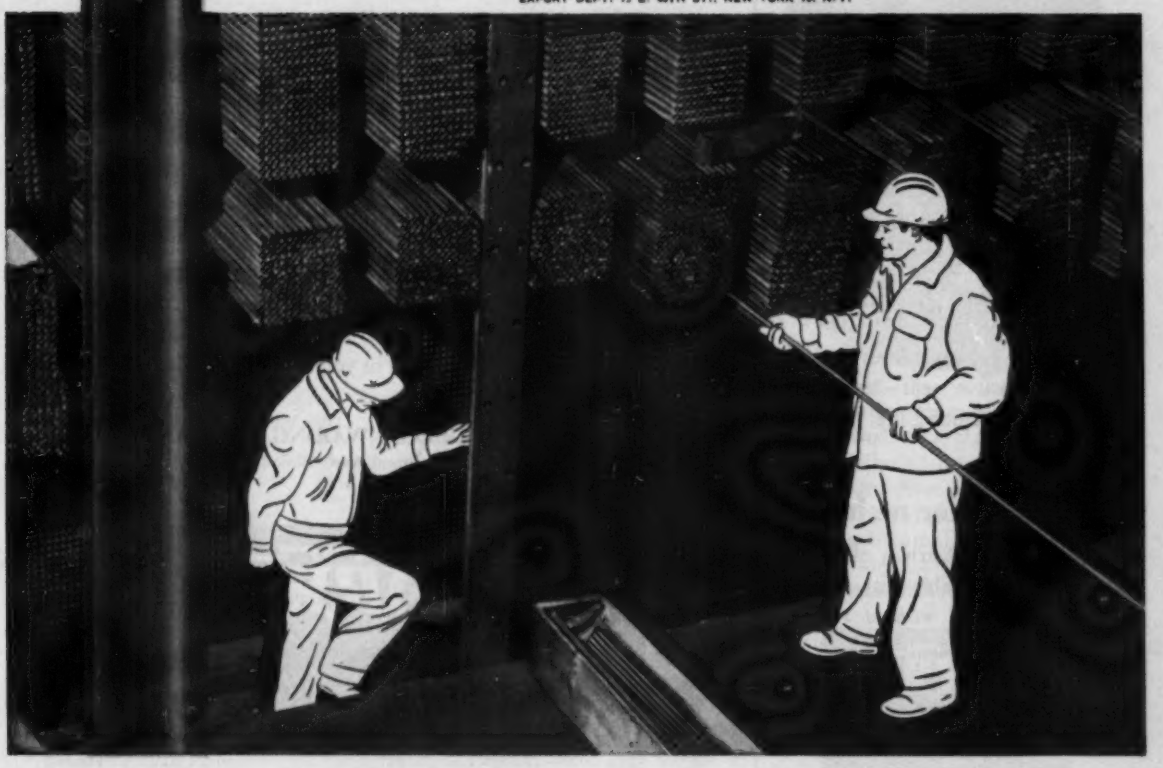
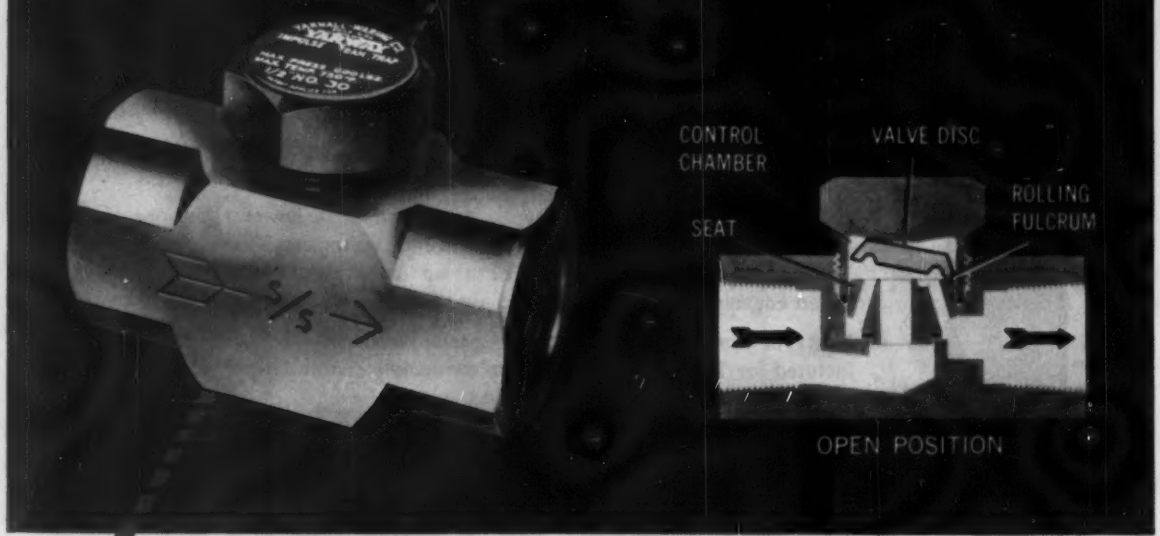


For more facts circle 256 on Reader Service card, p 109

Do your steam traps give you these 3 advantages?



1. Economy of operation on light loads?

The Yarway No. 30 gives you closer control—discharges condensate at full capacity, closes immediately on steam.

2. Longer service life?

Yarway's lever action reduces impact on valve seat—lessens wear, gives longer operating life. Quieter operation, too!

3. Lower maintenance?

Only Yarway offers an Impulse trap with renewable seat and disc that *can be replaced without removing the trap from the line.*

Why settle for less? Get all three money-saving advantages with Yarway No. 30—plus these time-proven advantages of all Yarway Impulse traps: quick heat-up, even temperatures, small size, stainless steel construction, non-freezing.

Nearly 1,300,000 Yarway Impulse traps already installed. Stocked and sold by 270 Industrial Distributors. Ask *your* distributor to arrange a free 90-day trial in your plant. Or write us.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.

YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

For more facts circle 257 on Reader Service card, p 109

Free literature

Begins on page 110

MATERIALS HANDLING

181 **Pneumatic conveyors** for ash handling are featured in 4-p well-illustrated catalog P-60. National Conveyors Company, Inc

182 **Roller chain,** heavy-duty type, is described in folder. Atlas Chain & Mfg Co

ELECTRICAL TRANSFORMATION AND CONVERSION

183 **Dry type transformers,** sound rated, are topic of booklet giving product data and manufacturing facts. Sorgel Electric Company

184 **Zener diodes for referencing** and instrumentation are detailed in 8-p bulletin RN-1159 International Rectifier Corporation

ELECTRICAL DISTRIBUTION AND PROTECTION

185 **Actuators** for pushbutton-switch assemblies are introduced in 8-p data sheet 150b. Minneapolis-Honeywell Regulator Company

186 **Proximity switch** for limit, interlock, counter or indicator sensors in unfavorable conditions is detailed in 4-p data sheet 163. Minneapolis-Honeywell Regulator Company, Micro Switch Div

187 **Molded-case circuit breakers** are featured in bulletin GEA-7070. General Electric Company

188 **Molded-case circuit breakers,** individually enclosed low-power circuit breakers and engineered products of firm are listed, described with specs in 60-p illustrated catalog of firm's line, designed for quick reference. I-T-E Circuit Breaker Co

HEAT EXCHANGE

189 **Industrial heat-exchanger-selection** data form covers firm's complete line. Air Preheater Corp

190 **Fixed-tube-bundle** heat exchangers, copper-base alloy, steel and stainless-steel types, are featured in 16-p catalog 1258A. Pressure ratings, specs, construction features, selection info are included. Young Radiator Co

191 **Inconel heat-exchanger tubing,** nuclear quality, is described in spec sheet STC-107. Superior Tube Company

INSTRUMENTATION

192 **Digital-computer paper-tape** accessories are detailed in data sheet. Bendix Aviation Corp, Bendix Computer Div

193 **Instruments for generating** plants distribution areas substations and electrical testing are topic of 12-p brochure GEZ-2975. General Electric Company

194 **Dose-rate alarm,** pocket sized, for protection against nuclear-radiation hazards and radioactive fallout is described with specs in new-product bulletin. Controls for Radiation, Inc

195 **Distribution voltage regulators** are featured in 16-p bulletin 21B7977E. Well-illustrated catalog gives construction, operation features and tabular info on ratings. Allis-Chalmers Mfg Co

196 **Remote-control systems** for nuclear industry are described and illustrated in 12-p catalog. Photos and drawings aid explanation. Teleflex Inc

197 **High-pressure boiler-water gage** is described in spec sheet. Jerguson Gage & Valve Company

198 **Multi-range speed recorder,** expanded-scale type, is discussed according to application, features, principles of operation and specs in 4-p bulletin GET-2741-3A. General Electric Company

199 **Control catalog** lists complete line of hermetically sealed mercury switches, transformer relays—has 56 pp. Gives description, specs and engineering data for each control. Mercoid Corp

200 **Rotameters** used for corrosive applications are topic of 8-p bulletin 150. Various types of meter designs are described and illustrated. Brooks Rotameter Co

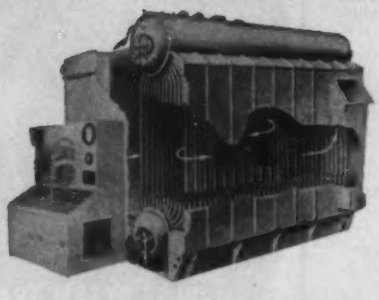
"All of a sudden, there they were!"

This Yarway team has scored high—1,300,000 installed on all types of steam equipment. Stocked and sold by 270 Industrial Distributors. For free Steam Trap Book, write YARNALL-WARING Co., 100 Mermaid Ave., Phila. 18, Pa.

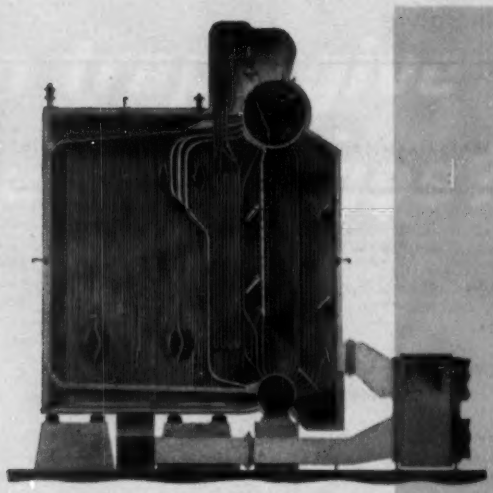
YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

circle 258 on Reader Service card, p 109

OIL AND GAS FIRED BOILERS
(standardized designs)



C-E Shop Assembled Boiler, Type VP—Available in 23 sizes ranging from 4000 to 90,000 lb of steam per hr capacity . . . pressures to 700 psi. Available with integral console control panel. This unit contains more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type.



C-E Vertical-Unit Boiler, Type VU-55—Available in five sizes . . . capacities from 70,000 to 150,000 lb of steam per hr . . . designed for three pressures 250, 500 and 700 psi, and total steam temperatures up to 800 F. Equipped with tangential burners, 60-inch steam drum. Tangent tube waterwalls offer complete furnace protection, minimizing maintenance.

MODERN INDUSTRIAL

Advanced designs for any fuel, firing or capacity needs

All the designs pictured here have something in common. All are evolved from a basic design concept—a 2-drum, vertical boiler with fully water-cooled furnace in front of the boiler proper — a design which Combustion Engineering originated more than 30 years ago and which has enjoyed the widest acceptance.

All are fully integrated designs comprising boiler, furnace, fuel-burning and, where required, superheat and heat-recovery equipment, coordinated into a smoothly functioning unit.

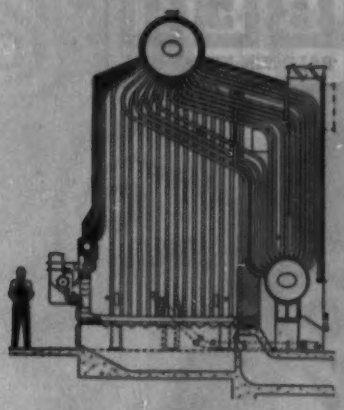
All have benefited from C-E's experience in meeting the most exacting standards in steam generation—the standards of the electric utility industry for which C-E has designed and built many of the boilers which are regarded as milestones in the industry's progress toward ever higher efficiency and economy.

All have demonstrated — in many installations — high standards of performance . . . economy, reliability and suitability for the particular fuel and operating conditions for which they were selected.

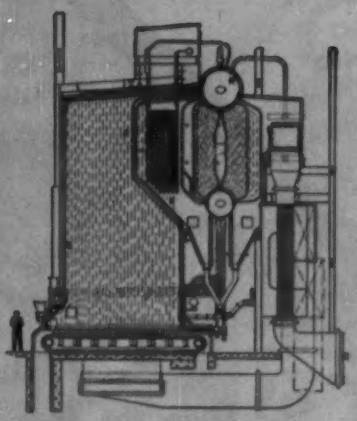
So — no matter what combination of conditions prevail at your plant, Combustion Engineering has a boiler unit that can meet your requirement, exactly — and economically. We'd like to discuss it with you and your consultants at your convenience.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

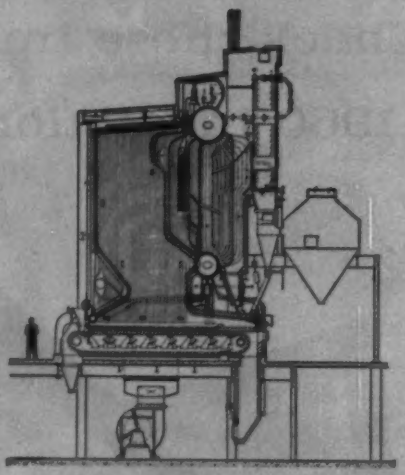
STOKER FIRED BOILERS



C-E Vertical-Unit Boiler, Type VU-10 — fired by a Spreader Stoker. VU-10 Boilers are available for capacities from 10,000 to 60,000 lb of steam per hr with pressures to 475 psi; superheat to 150 F. Can be equipped with Underfeed or Traveling Grate Stokers if desired.



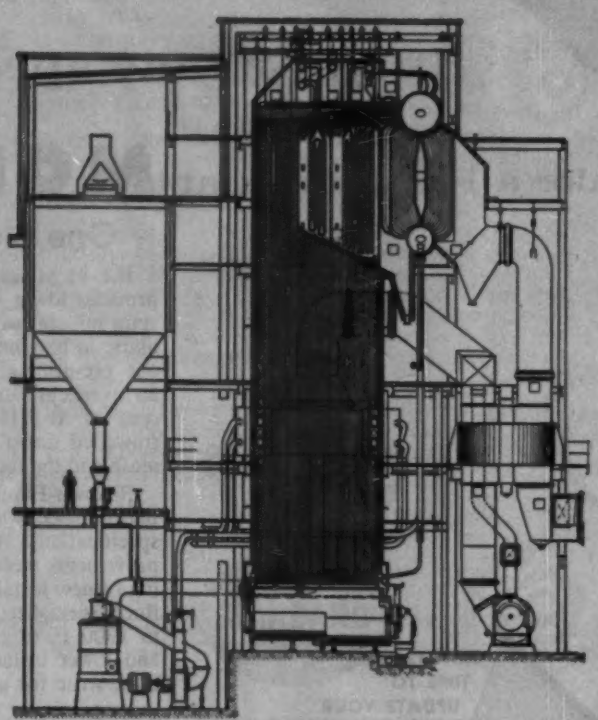
C-E Vertical-Unit Boiler, Type VU-40 — fired by Spreader Stoker, continuous discharge type — A baffleless boiler with capacities ranging up to about 300,000 lb of steam per hr, with pressures to 1,200 psi; temperatures to 950 F.



C-E Vertical-Unit Boiler, Type VU-50 — fired by Traveling Grate Stoker — Units of this design are suitable for capacities up to about 150,000 lb of steam per hr; pressures to 1,200 psi; temperatures to 950 F.

BOILERS

PULVERIZED COAL FIRED BOILERS



C-E Vertical-Unit Boiler, Type VU-40 — using C-E Raymond Bowl Mills and tilting, tangential burners — capacities up to about 600,000 lb of steam per hr, pressures to 1,200 psi, temperatures to 950 F.

Note: The drawings on this page are a few examples of the many units available for coal firing; all are readily adaptable to oil or gas firing.

COMBUSTION ENGINEERING

C-E

C-255

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PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more facts circle 259 on Reader Service card, p 109

Check these improved
1960 insulations

B E H
BALDWIN-EHRET-HILL

you'll want them
in your new specifications

Take a Fresh Look at **MONO-BLOCK®**

One Block Insulates up to 1800 F

B-E-H Mono-Block now spans the full range up to 1800 F; provides lower thermal conductivity, 0.63 at 800 F. Its long, spun mineral wool fibers form a strong, rigid block that stands abuse in handling — yet impales easily over studs or pins without pre-drilling, speeding application. Mono-Block provides an excellent surface for applying a single insulating-finishing coat of B-E-H Super Powerhouse Cement. This may be trowelled directly on the block — saving the expense of wire mesh and the time it takes to apply it.

Baldwin-Ehret-Hill has thrown a new light on insulation performance which will pay you well to consider in writing specifications. Continuing research and resulting product improvements meet advanced concepts in the design and engineering of new installations. You can depend on the B-E-H line of thirty specialized insulation products, for service from sub-zero to 1900 F, to give you better performance, easier application, and lower installed cost. To bring your specifications up to date, write for our 1960 catalog or see it in your Sweet's File.

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THE COMPLETE LINE OF INSULATIONS for use SUB-ZERO TO 1900 F.

CONTRACT APPLICATION SERVICE FROM COAST TO COAST

Sludge in engine ends with switch to STANODIESEL Oil M

Situation: For five years a 1,400 hp. engine in the Municipal Light Plant, Arcadia, Wisconsin, was operated on STANODIESEL Oil M. During this time the engine ran free and clean. It carried a major share of the plant's 20,000 kw. output. A decision was made to switch the engine to another lubricant since it was believed one oil was as good as another.

What happened: Within two years the engine had sludged up so much, the oil had to be removed and replaced by STANODIESEL Oil M. Three months later the engine had cleaned up and was again carrying its share of the plant's load.

Clean engine operation is possible with STANODIESEL Oil M because of its superior base stock and its combination of additives that are available in no other oil. Superior base stock and exclusive additives give you these cost-saving operating and maintenance advantages: less sludging, low oil consumption, reduced port deposits, fewer stuck rings, less need for ring replacements, less cylinder wear, lower filtration costs, fewer bearing problems.

Get more facts about STANODIESEL Oil M. Call the Standard Oil office near you in any of the 15 Midwest or Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

You expect more from **STANDARD** *and you get it!*

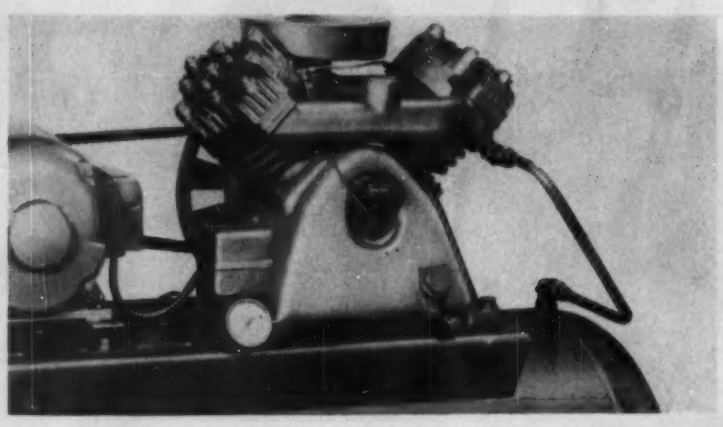
The team that got the engine back in shape; (l. to r.) Vernon Schwertel, Ronald Darbo and Standard's Fred Parkinson. Providing lubrication technical service on problems like this one is not new to Fred Parkinson. He's been doing it for 11 years. He has further qualification for such work—an engineering degree from Brown University. Fred has also completed the Standard Oil Sales Engineering School.

Quick facts about STANODIESEL Oil M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by economy fuels.
- Maintains film on difficult-to-lubricate parts.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil mix.

For more data on these developments, circle key numbers on Reader Service card, p 109

Plant equipment news... Your



"X" shape dominates new compressor from flywheel to oil fill

1 • "X" type compressor to balance all reciprocating forces is firm's product answer to 2½ years of comparative researching in compressor field. New unit is said to be vibration free, with short piston strokes for less wear. "X" shape limits rocking motion caused by reciprocating forces acting in opposite directions and producing vibration and wear, according to manufacturer.

Spiral design of intake muffler keeps it silent. Muffler cap is an air-locking sound trap. Entire cylinder area is capped with valves for free flow of air—in and out. Valve strips are made of corrosionproof stainless steel. Only two valve plates and strips make up entire valve service for each cylinder—no springs, guides, channels.

Extra-deep, closely spaced fins solve cooling problem. Crankshaft is made of ductile iron with tensile strength of steel—80,000-psi minimum. Crankpin is flame hardened for wear resistance.

"X" shape sets each cylinder at a 45-deg angle from the horizontal, in physical and dynamic balance with overall shape and stance for reciprocating balance. Ratings are 1½ to 15 hp, 40 to 250 psia with 1750 rpm, available in 1- or 2-stage models. Unit is provided with formed-steel mounting plate complete with motor slide for belt-tension adjustment.—Worthington Corp

Static-excitation system claims easy maintenance

2 • Static-excitation-system eliminates moving dc unit for medium-capacity steam turbine-generators. System, designed to replace rotating exciters, will be factory tested this spring. This 90-kw system will be used on a 25,600-kva generator.

According to manufacturer, prime advantage of static-excitation system is the elimination of all moving parts for maintenance ease. If servicing is necessary it can be undertaken without removing load from generator. Power for the unit is obtained from connection to generator terminals. Circuit uses both a current transformer and potential transformer as power source.—General Electric Co

Oil-bath air filter has no moving parts

3 • Automatic self-cleaning air cleaner is said to have high efficiency, low maintenance requirements. Oil-bath air filter has pneumatic lift—simplified method of lifting oil from the reservoir to perforated oil-distribution plate which in turn relays oil to the pads.

Unit has no moving parts. Lift replaces motor-driven circulator and eliminates need for electrical power. Motor lubrication, brush replacements and circulation wear are eliminated, says maker. Cleanout door eases maintenance and "bullseye" gage to observe and help control oil level also eliminates studs sicking from top.—American Air Filter Co, Inc

Stored energy activates switch-transfer mechanism

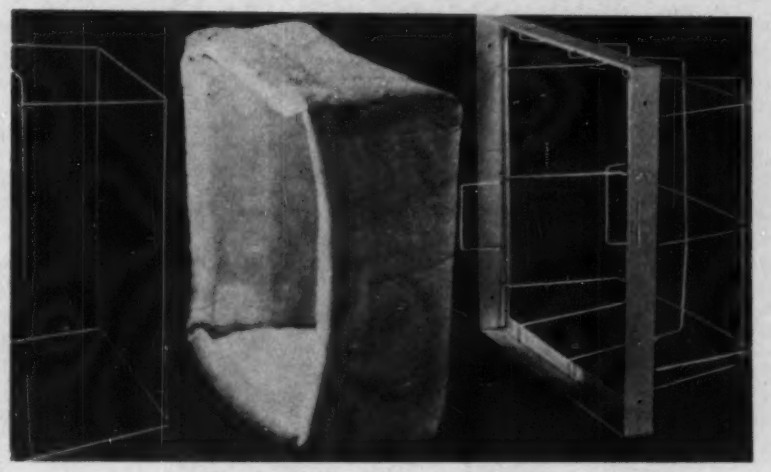
4 • Dual-cylinder double-throw automatic switch-transfer mechanism was designed for power users who would find an extended service interruption disastrous. Activated by loss of preferred-source voltage, switch opens preferred-source-disconnect switch and closes another to instantly transfer to emergency power. Timing device selects from 0- to 30-sec time delay to allow circuit breakers to operate properly before triggering cylinder for preferred switch. When preferred switch is opened, signal is immediately relayed to close emergency switch and cut in emergency power source without any interruption of power.—H K Porter Co, Inc

Air-adjusted pilots control to within ½ psi

5 • Air-adjusted pressure pilots are said to have control accuracy to within ½ psi or better from positive pressures through vacuum range to 30-in. Hg. Units can also be used in conjunction with a process-temperature recorder-controller.

Remote air loading of the pilot, by locating pressure-adjusting panel at any convenient distance from the regulator, makes centralized control possible. You can save on fuel and get greater control stability by mounting the pilot at the valve.

Economical use of adjusting air is assured since air is bled only when the setting is being changed. Maintenance and repair time is kept to a minimum by easily accessible orifices. Units have bronze diaphragms but cast-iron, bronze and steel pilots are available for pressures to 600 psi.—Spence Engineering Co, Inc



Cubic air filter boasts long life

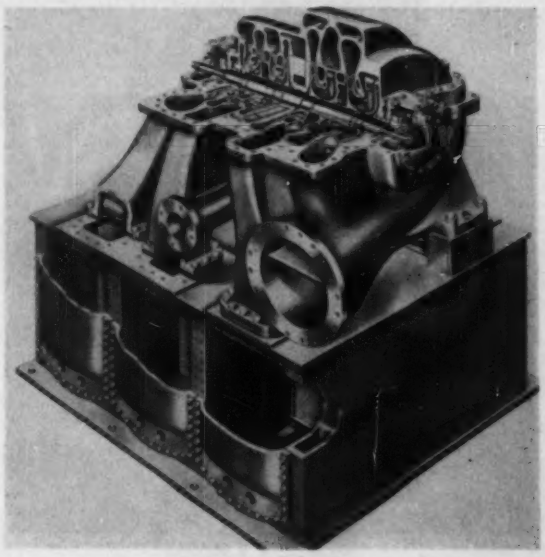
6 • "Cube"-constructed replacement filter claims service life at least six times longer than throw-away and permanent metal type filters. According to maker, unit combines high efficiency with low pressure drop even after it has collected several lb of dirt. Filtering action is attributed to lightweight Dynel Modacrylic filtering medium, filter batt and open-side-cube construction. Air stream carries dirt into cube, to front surface of downstream face of filter. Dirt builds up in downstream face and air flow is shunted to sides of cube. Four side traps filter fine particles while downstream face filters the coarse. Filter medium is unaffected by moisture. Unit is rated 0.04-in. press. drop at 2000 cfm.—Union Carbide Development Company, Inc

Air compressor will furnish 110 psi

7 • Multistage centrifugal air compressor is designed to furnish "100-lb air" for oxygen plants, centralized air systems and other industrial applications. Unit has integral intercoolers between each stage of compression for high efficiency, says maker.

A feature: side connections permit up or down piping, eliminate space-consuming axial inlets. Piping is on same side as cooler boxes to take advantage of clearance required for removal of intercoolers.

Need for a thrust-balance device is eliminated by back-to-back impeller design said to provide inherent thrust balance. Unit has only two journals and one thrust bearing—wearing surfaces should be cut to a minimum. Bearing supports are cast integral with the case, assuring permanent alignment for the life of the machine, says manufacturer. Unit can be furnished with induction or synchronous motor or can be adapted for other types of prime movers.—Clark Bros Company



For more data on these developments, circle key numbers on Reader Service card, p 109

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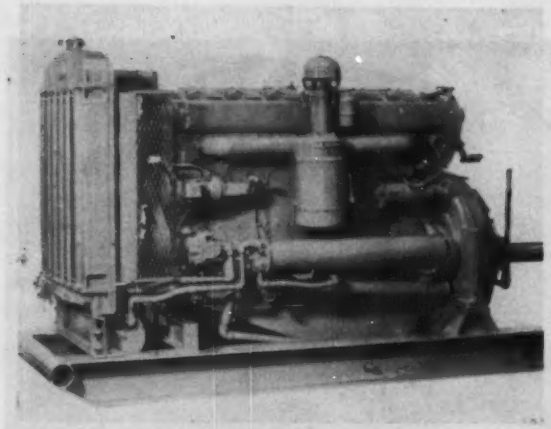
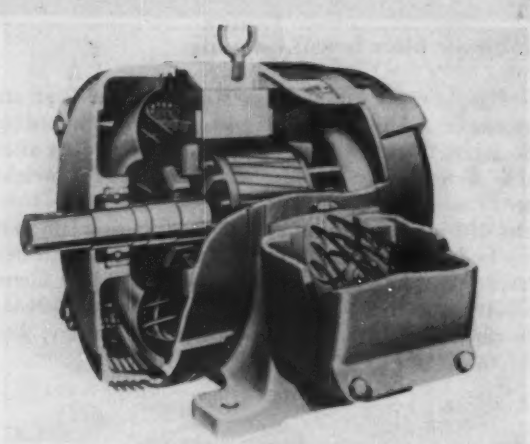


Diesel engine has high-rising torque

8 • Engine is designed to put more power into a job and help keep equipment at right operating speed for efficient production, according to manufacturer. Total amount of power that goes into any job is determined by engine's reaction to load and speed changes. Torque characteristics of an engine determine these changes. Because of high-rising torque of this diesel, more power can be put into a job as needed, says maker.

Unit should be able to take hold of a load and keep it going with a sort of lugging power. This kind of functioning helps keep equipment at right operating speed for efficient production. Units are available from 105 to 320 hp in dual-fuel models capable of delivering mechanical and electrical power simultaneously. Generator sets have capacities from 60 to 188 kw.—Murphy Diesel Co

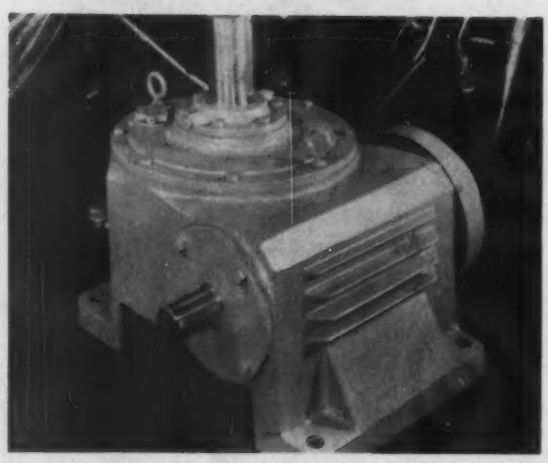


Squirrel-cage motors have 3- to 75-hp rating

9 • Squirrel-cage motors for outdoor field pumping service should provide top performance over wide voltage range. Units have low magnetizing current for high power factor even at overvoltage and high starting torque for positive breakaway at low voltage. High-slip high-inertia design is employed to minimize current peaks caused by cyclic loading.

Both stator and rotor are designed to handle short-time overloads. Baffling in both brackets should protect against rain and sleet.

Unit has cast-iron frame, gasketed conduit box and silicone thermosetting insulating varnish for corrosion resistance and protection against dirt and moisture. Bearings are protected. — Westinghouse Electric Corp



Reducer exhibits compact design

10 • Worm gear reducer has fan-cooled design for saving space and weight while transmitting maximum loading on worm and gear, says maker. Gear material of centrifugally cast phosphor bronze shows mechanical strength, good wearing properties and low coefficient of friction.

This design features better balancing of mechanical and thermal ratings. No connecting piping, circulating water and cooling coils in lower casing are needed. According to maker a 100-F rise above ambient will never be exceeded.

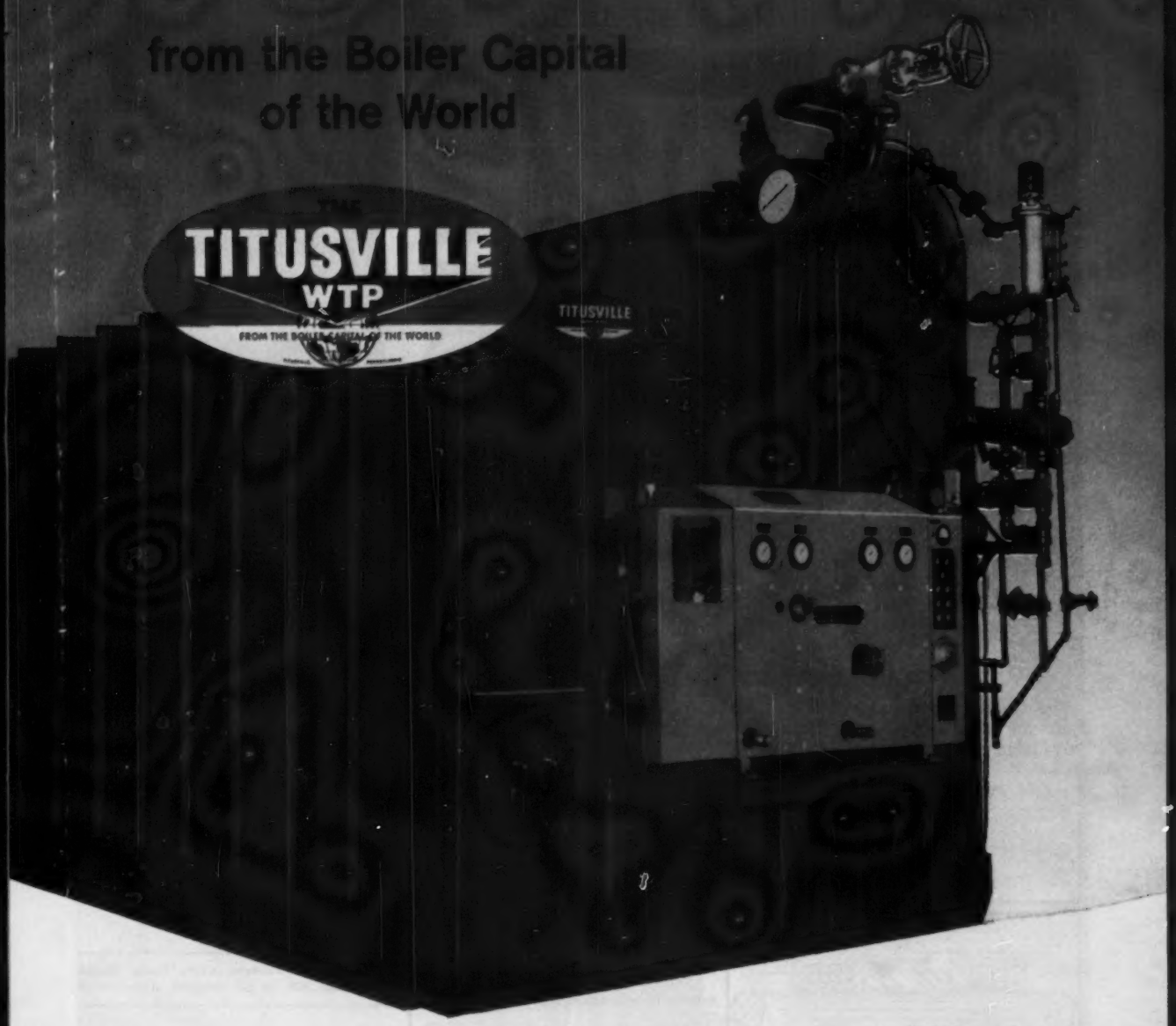
Fan provides motion of air—a factor in increasing heat dissipation in higher speed range where power rating would be thermally limited. Units are available from 1/10 to 150 hp.—De Laval Steam Turbine Company

For more data on these developments, circle key numbers on Reader Service card, p 109

continued

Bonus Life...Bonus Protection

from the Boiler Capital of the World



BONUS LIFE means longer life and less refractory maintenance made possible by Titusville's unique WTP design.

65% Black Surface Tube Area coverage on rear wall. Titusville's increased black surface tube area means less refractory maintenance through longer refractory life (less down-time for replacement) and a faster steamer.

BONUS PROTECTION (solves the H_2SO_4 problem). Most water tube steam generators operate intermittently. When dew point is approached at low fire condition, H_2SO_4 can form quickly in *single casing* boilers. Titusville WTP's *double casing* design (with insulation between) reduces temperature differential. *Result:* formation of H_2SO_4 almost entirely eliminated for many times more casing life.

VMA 6979

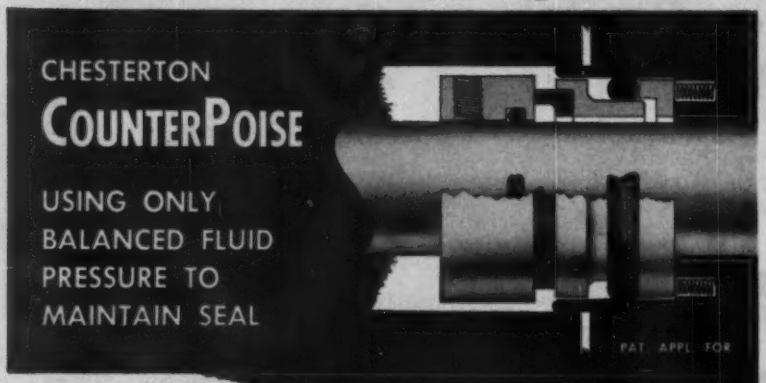
THE TITUSVILLE IRON WORKS COMPANY
TITUSVILLE, PENNSYLVANIA

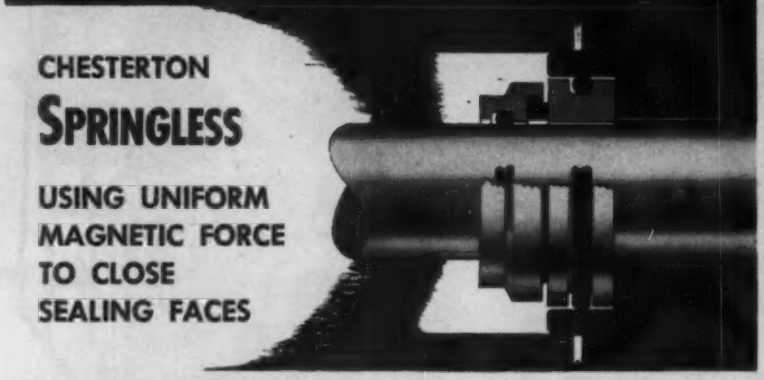
Division of Struthers Wells Corporation

For your **BONUS LIFE** and **BONUS PROTECTION**, specify **WTP** from **Titusville**

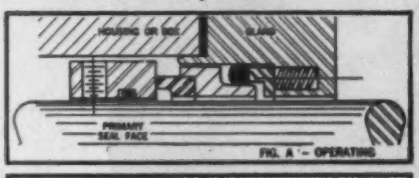
For more facts circle 262 on Reader Service card, p 109

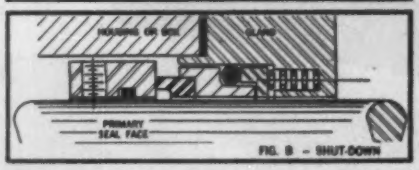
Which of these two ingenious **SEALS** *will solve your problem?*





The CHESTERTON COUNTERPOISE and CHESTERTON SPRINGLESS SEALS are the two newest, most ingenious and most advanced design seals available to industry.





When the COUNTERPOISE SEAL *is in operation (fig. A) springs are disengaged and the sealing faces are held in contact by uniform fluid pressure only! During shut-down (fig. B) springs are in operation, taking over the closing function normally maintained by fluid pressure when the pump is in operation.*

Both new seals operate on the sound principal that sealing faces should *not* be mated by the unreliable and uneven pressures of springs. Conventional springs become fatigued, clogged by sediment or corroded thus causing uneven face wear. A warped face rapidly loses its sealing action. In the CHESTERTON COUNTERPOISE SEAL the fluid pressure maintains a uniform, balanced face pressure eliminating unevenly worn faces. The springs only operate during shut-down or sudden vacuum conditions. They are isolated from corrosive fluids or abrasives. Become acquainted with the newest and most advanced seals in industry by sending for our brochures and then decide which of these two ingenious seals will solve your problem.

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America's Oldest Manufacturer of Mechanical Packings

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Equipment news

Begins on page 126

Reverse-power relay

33 • New directionally controlled timing relay is for reverse-power 3-phase applications. Unit is rated 120-v line-to-line, 5 amp. Main contacts can close 30 amp at 250-v dc and carry this for sufficient time to trip a circuit breaker, says maker. Unit is completely self-contained.—Westinghouse Electric Corporation

Just circle key numbers on the Reader Service card, page 109, to get complete product story

Variable-speed pulleys

25 • Pulleys are as easy to install as an ordinary V-belt drive yet permit accurate judgment over wide range of speeds, maker claims. Construction features include curved pulley faces for full belt contact, high ratio for small face diameter, positive lubrication and compact, lightweight construction. Sizes range upward from 1 hp, speed ratios to 2.8:1. Lovejoy Flexible Coupling Co

continued

JOHNSON CONTROL SETS THE PACE . . . For 75 years, engineers, architects, and owners have relied on Johnson for the temperature control systems used in the nation's leading buildings! Johnson leadership spans the life of the control industry . . . from Warren Johnson's invention of the first thermostat to the very latest in air-conditioning control centers. You can continue to look to Johnson for the world's finest controls!

Johnson Service Company, Milwaukee 1, Wisconsin • 205 Direct Branch Offices

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PNEUMATIC SYSTEMS

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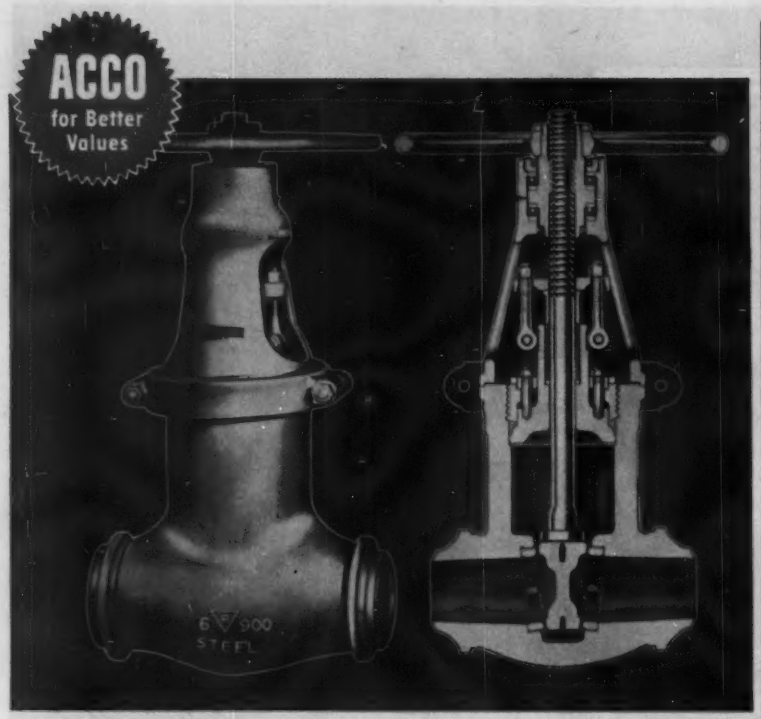


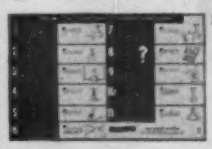
R-P&C Pressure Seal Valves
for high pressure, high temperature applications

The soundness and reliability of the pressure seal bonnet joint in R-P&C high pressure cast steel valves has been thoroughly proven by field experience and use. Built to give continuous dependable service in modern high pressure systems, they offer these advantages:

1. **Pressure Seal Joint designed to secure maximum mechanical efficiency. Valve bonnet may be removed or re-assembled more readily than a conventional bolted bonnet valve**
2. **Elimination of flanges reduces weight in suspended piping**
3. **Modern design with neat contours facilitates insulation**
4. **Compensating type Wedge, adjusts for tight closure and to overcome sticking or jamming when seated**
5. **Manufacturer's complete quality control. Valve Castings are produced in R-P&C foundry under the supervision of R-P&C Technical personnel. All pressure seal valve castings are subject to critical internal examination in R-P&C's own Radiographic X-ray facilities**

R-P&C Pressure Seal Valves are available in gate design thru 14" size. Globes and Lift Checks available thru 8" size—all in the 900-1500 and 2500 pound classes.

R-P&C Distributors offer users in the Power Industry—in addition to these Pressure Seal Valves—a complete line of R-P&C gate, globe and angle valves in all standard materials: electric furnace iron, bronze, bar stock, cast steel...plus many specialties. See your distributor or write our Reading, Pa., office.



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"How to Protect Your Valves"

This 22" x 17" chart gives valuable installation pointers, operating tips, clues to longer service life. For free copy, write us at Reading, Pa.

R-P&C VALVES

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R-P&C Valve Division, American Chain & Cable Company, Inc.

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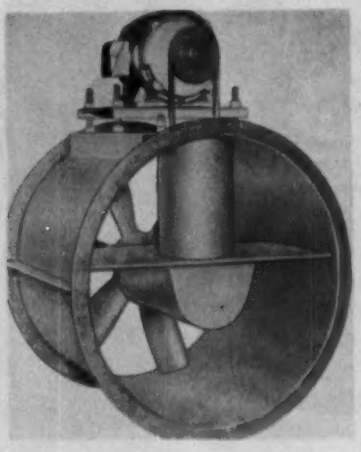
Equipment news

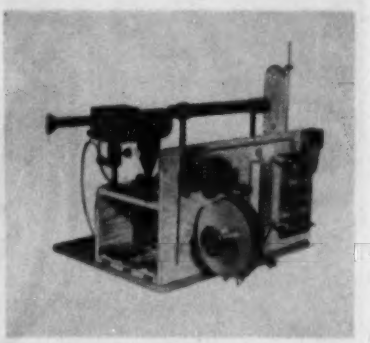
Begins on page 126



Fiberglass duct fans

42 • Duct fans come in sizes from 12 to 36 in. According to maker, they offer resistance to corrosion equal to or exceeding that of stainless steel or monel construction. Propeller, dust section, drive housing and bearing cover are made of fiberglass; drive shaft and hardware are stainless steel. — Hartzell Propeller Fan Company

Just circle key numbers on the Reader Service card, page 109, to get complete product story



Pyrometer-calibrating set

35 • Unit was designed for versatility and precision needed to permit

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MEET THE MAN WHO CAN PROTECT & PRESERVE YOUR AIR CONDITIONING EQUIPMENT FROM THE DAMAGING EFFECTS OF WATER

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* CONSCIENTIOUS & EFFECTIVE SERVICE BACKED BY 44 YEARS OF COMPANY KNOW-HOW.

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- CONTROLLING WATER TO PREVENT SCALE • RUST • SLIME ALGAE • CORROSION • CONGESTION

New and increasingly complex cooling systems require advanced and thoroughly effective treatment programs. Protect your investment and be assured of uninterrupted and efficient operation with MOGUL PRODUCTS and MOGUL SERVICE.

The North American MOGUL Products Company
Standard Building • Cleveland 13, Ohio

Insulation Contractor: Precision Insulation Co., Houston

"30% saving on handling and wastage alone . . . with G-B SNAP*ON®"

This experience of an insulation contractor highlights one of the many advantages of G-B SNAP*ON, the original one-piece pipe insulation molded of fine glass fibers:

*"When we recently installed about two miles of G-B SNAP*ON and a rigid type insulation, we had a good opportunity to compare the two. Much of the job required dragging insulation through wet, muddy crawl spaces. The way G-B SNAP*ON stood up under this abuse, with practically no waste, convinced me it is the ideal pipe insulation. We figure we saved 30% on handling and wastage alone by using G-B SNAP*ON."*

Featherweight 3′ and 6′ sections of G-B SNAP*ON also cost less to apply! "SNAP"—and the pipe is covered, even in tight spots and close quarters. So outstanding is its thermal efficiency that 1½" G-B SNAP*ON is thermally superior to most 2" insulations—more permanent, too. For your next pipe insulating job, be it large or small, hot or cold, specify G-B SNAP*ON and discover its many outstanding features for yourself!

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SEE YOUR G-B SNAP*ON DISTRIBUTOR
(LISTED IN ADJOINING COLUMN)

GUSTIN-BACON *Manufacturing Company* GUSTIN gb BACON®

242 W. 10th ST., KANSAS CITY, MO.

Thermal and acoustical glass fiber insulations . . . Molded glass fiber pipe insulation
Couplings and fittings for plain and grooved end pipe

G-B SNAP-ON DISTRIBUTORS

LISTED IN YELLOW PAGES

(See ad on facing page)

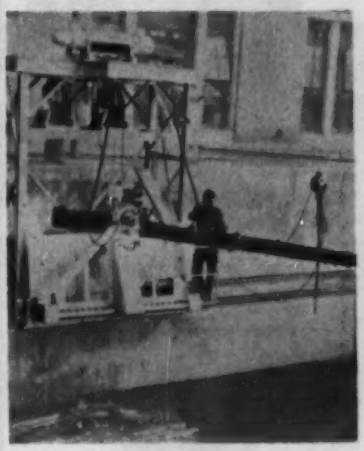
AKRON, Ohio, The Asbestos Supply Co.
ALBANY, Ga., Industry Insulation Co.
ALBANY, N. Y., Hudson Valley Asbestos Corp.
ALBUQUERQUE, N. M., Mt. States Insulation Co.
AMARILLO, Tex., McDonald Engineering & Insulating Co.
ATLANTA, Ga., Reynolds Aluminum Supply Co.
AUSTIN, Tex., Cinbar Engineering Co.
BALTIMORE, Md., Leroy Insulation Co.
BANGOR, Me., Eastern Glass Co.
BATON ROUGE, La., Eagle Asbestos & Pkg. Co.
BEAUMONT, Tex., Solar Supply Co.
BILLINGS, Mont., Big Horn Supply, Inc.
BIRMINGHAM, Ala., Reynolds Aluminum Supply Co
Shook & Fletcher Supply Co.
BORGER, Tex., Western Chemical Co.
BOSTON, Mass., Homans-Kohler, Inc.
BUFFALO, N. Y., Industrial Insulation Sales, Inc
CHAMPAGNE, Ill., Lewie David Co.
CHARLESTON, W. Va., Asbestos & Insulating Co.
CHARLOTTE, N. C., D&B Insulation Co.
CHICAGO, Ill., E. C. Carlson Co.
Culberg Asbestos & Cork Co.
CHILLICOTHE, Ohio, Southern Ohio Insulating Co.
CINCINNATI, Ohio, R. E. Kramig Co.
CLEVELAND, Ohio, Ohio Asbestos & Insulation Co.
COLUMBIA, S. C., Industrial Insulation Div. of
Richland Oil Co.
COLUMBUS, Ohio, Santeler Brothers
Colberg of Ohio
CORPUS CHRISTI, Tex., Precision Insulation Co.
DALLAS, Texas, Acme Insulation & Supply Co.
DAVENPORT, Iowa, Republic Electric Co.
DAYTONA BEACH, Fla., B & F Insulation Co.
DENVER, Colo., Gene Wright Lumber Co.
Powers Industrial Insulation, Inc.
DES MOINES, Iowa, Iowa Asbestos Company, Inc.
DETROIT, Mich., The Walter Rankin Co.
ERIE, Pa., Laco-McMullen Co.
EVANSVILLE, Ind., George Koch Sons, Inc.
FALCONER, N. Y., Laco Roofing
FT. SMITH, Ark., Gunn Distributing Co.
FT. WAYNE, Ind., M. H. Hilt, Inc.
FT. WORTH, Tex., Bracken Co.
GREENSBORO, N. C., Starr Davis Co., Inc.
GULFPORT, Miss., Paine Supply Co.
HOUSTON, Tex., Precision Insulation Co.
INDIANAPOLIS, Ind., Lyon Lumber & Supply Co.
JACKSON, Miss., Paine Refrigeration & Supply Co.
JACKSONVILLE, Fla., Eckles Distributors, Inc.
Reynolds Alum. Sup. Co.
JOPLIN, Mo., Joplin Cement Co.
KANSAS CITY, Mo., Central Supply Co.
KEWANEE, Ill., Mechanical Insulation Co., Inc.
LAKE CHARLES, La., Solar Supply Co.
LITTLE ROCK, Ark., Gunn Distributing Co.
LOS ANGELES, Calif., Western Fibrous Glass Prod. Co.
LOUISVILLE, Ky., General Insulation & Roofing Co.
MACON, Ga., Industry Insulation Co.
MARIETTA, Ohio, Asbestos & Insulating Co.
MEMPHIS, Tenn., John A. Denie's Sons, Co.
Gibbons Supply Co.
MIAMI, Fla., Reynolds Aluminum Supply Co.
Southern Metal Products Co.
MILWAUKEE, Wisc., F. R. Dengel Co.
MINNEAPOLIS, Minn., Asbestos Products, Inc.
MOBILE, Ala., Shook & Fletcher Insulation
MONTGOMERY, Ala., Shook & Fletcher Supply
MOORHEAD, Minn., Fargo-Moorhead Insulation Co.
NASHVILLE, Tenn., Reynolds Aluminum Supply Co.
NEWARK, N. J., Eastern Steam Specialty Co.
NEW ORLEANS, La., Eagle Asbestos & Packing Co.
NEW YORK, N. Y., Eastern Steam Specialty Co.
ODESSA, Tex., Western Chem. & Supply
OKLAHOMA CITY, Okla., Ball Distributing & Engr. Co.
OMAHA, Nebr., Cardinal Supply & Mfg. Co.
ORANGE, Conn., Insulation Supply Co.
PADUCAH, Ky., Triangle Insulation Co.
PHILADELPHIA, Pa., John F. Scanlan, Inc.
PHOENIX, Ariz., Kircher Asbestos & Rubber Co.
PITTSBURGH, Pa., Keystone Div. of Dravo Corp.
PORTLAND, Me., Eastern Glass Co.
PORTLAND, Ore., Western Fibrous Glass
RALEIGH, N. C., Reynolds Aluminum Supply Co.
RAPID CITY, S. D., Robbins & Stearns Wholesale
RICHMOND, Va., Reynolds Aluminum Supply Co.
ROANOKE, Va., C. E. Thurston Co.
ROCKFORD, Ill., Mott Brothers Co.
SALT LAKE CITY, Utah, Bullough Asbestos Sup. Co.
SAN ANTONIO, Tex., San Antonio Machine & Supply Co.
SAN DIEGO, Calif., Western Fibrous Glass Prod. Co.
SAN FRANCISCO, Calif., Western Fibrous Glass Prod. Co.
SAVANNAH, Ga., Reynolds Aluminum Supply Co.
SEATTLE, Wash., Western Fibrous Glass Products Co.
SHREVEPORT, La., Frith Sales Co.
SOMERVILLE, Mass., Insulation Products, Inc.
ST. LOUIS, Mo., The Stovey Company, Inc.
ST. PAUL, Minn., Asbestos Products, Inc.
SULLIVAN, Ill., Lewie David, Inc.
SYRACUSE, N. Y., Burnett Process, Inc.
TAMPA, Fla., Eagle Roofing & Art Metal Works, Inc.
TULSA, Okla., Ball Distributing & Engr. Co.
TUPELO, Miss., Paine Supply Co.
WASHINGTON, D. C., Walter E. Campbell Co., Inc.
WEST PALM BEACH, Fla., Southern Metal Prod.
WICHITA, Kans., General Metals, Inc.

circle 267 on Reader Service card, p 109

Equipment news

Begins on page 126

accurate calibration of any two optical pyrometers. It is a totally packaged set ready to use and certified by the National Bureau of Standards. Wide filament-strip lamp can be adjusted by step and vernier rheostats to any desired temperature range from 1400 to 4200 F.—Pyrometer Instrument Co, Inc



Hydraulic rack rake

37 • Trashrake is for dams, hydroelectric stations and other installations where trash removal from water-inlet racks is a problem. Unit has digging action which removes trash from bottom of racks, keeping them clear for their full length. Standard equipment includes power operation for carriage traverse and rake hoistings.—The Portland Co

Just circle key numbers on the Reader Service card, page 109, to get complete product story

Protective soldering cream

24 • Soldering cream increases activity of flux without use of mineral acids, protects soldered metal from corrosion, states maker. Cream can be used on phosphor bronze, tinned steel, galvanized iron, copper, brass

CONTROL ATOMIZING STEAM...

AT AN ADJUSTED PRESSURE HIGHER

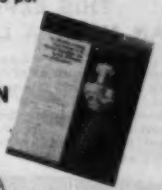
OR LOWER THAN THE FUEL OIL PRESSURE

These new differential pressure regulators have in common a number of outstanding features for steam service.

CHECK THESE FEATURES FOR YOURSELF

- ☐ Straight through design for low friction loss and elimination of clogging by dirt
- ☐ Spring loaded. Perfectly balanced
- ☐ Shear port design. Honed guide
- ☐ Simple in design with minimum number of moving parts
- ☐ Exterior adjustable stop for limiting open and closed positions
- ☐ Simple to service. No internal adjustments
- ☐ No stuffing boxes or moving parts
- ☐ Regulate differential pressure within narrow limits
- ☐ Telltale port indicates rupture of either steam or oil diaphragm
- ☐ "O" ring seals suitable for 400°F.
- ☐ Range of differential pressure adjustment 5 to 45 psi

SEND FOR BULLETIN 1059



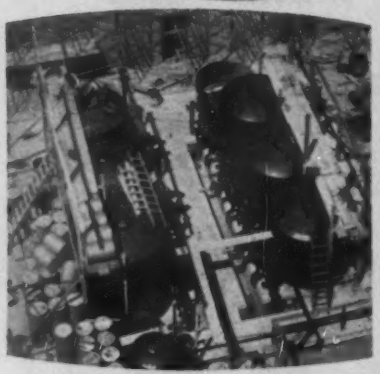
ATLAS VALVE CO.
280 South Street
Newark 5, N. J.
Mitchell 2-2464

circle 268 on Reader Service card, p 109

PATHWAYS OF A PIONEER

ILLCO-WAY DESIGNERS AND BUILDERS

MODERN EQUIPMENT FOR ionXchange



This picture was taken in *1943* of a Continuous *600 gpm* IonXchanger during installation at a midwestern chemical plant. The tanks are shown being loaded with ionXchange resins.

Blazing the Trail for De-I Developments

When the photograph above was made, IWT already had well over 50 large industrial ionXchangers in successful operation — yet ion-exchange in those days was still considered a "new and untried" process! Many of these pioneering IWT installations are *in use today*, and most of the early users of IWT ionXchange have *added to* and *modernized* their equipment as new developments became available.

Even today IWT is still pioneering — adding to its great stock of knowledge in this specialized field, designing and building up-to-date ionXchangers of all types and sizes for application to a wide variety of processes as well as all kinds of water-treatment, experimenting with and carefully testing new ionXchange uses, and constantly improving existing designs.

THIS EXPERIENCE CAN MEAN A LOT TO YOU

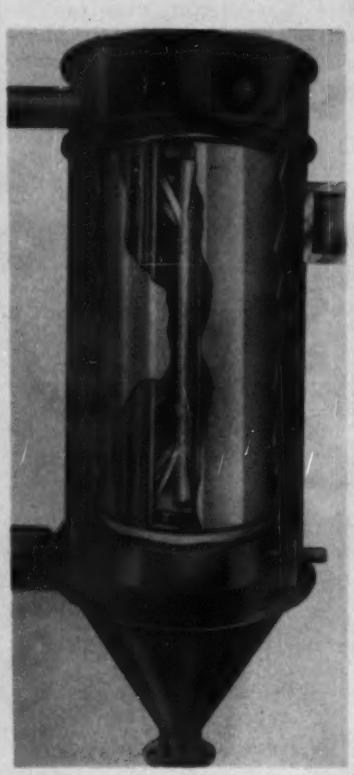
If you need pure water for high-pressure boiler make-up or process use, or if you are considering the use of ion-exchange for purification or concentration of chemical products, be sure to take advantage of IWT pioneering experience and specialized knowledge. *Call your IWT representative.*

ILLINOIS WATER TREATMENT CO.
840 CEDAR ST., ROCKFORD, ILLINOIS
NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

Equipment news

Begins on page 126

and for sweating jobs. It gives off no toxic fumes and should be safe under any conditions.—Farrelloy Company



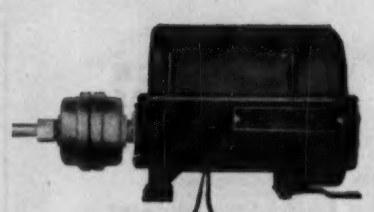
Centrifugal dust collector

21 • Cloth dust collector with centrifugal action, rotating blow tube, roller-support system has high air-cloth ratio and reduced space requirements. Small, medium and large sizes are available.—Dustex Corp

Just circle key numbers on the Reader Service card, page 109, to get complete product story

Molybdenum-disulfide lube

18 • Lubricant is for extreme-pressure and wear-reduction applications, according to manufacturer. Because pressure characteristics do not come from fusion of additives at elevated temperatures, it is suitable for slow-



Let Speed Measurements Help You

Let the Esterline-Angus Speed Recorder System provide you with records that will help you

- **determine production rates,**
- **control product quality,**
- **check performance of equipment and machinery,**
- **establish operator efficiency and safety.**

All you do is connect the shaft of the E/A Tachometer Generator (above) to any equipment whose speed you want to measure.

The Tachometer Generator actuates an E/A strip-chart Speed Recorder (below) giving you an accurate, permanent, indisputable record.

There's no end to the applications of the E/A Speed Recorder. For instance, in continuous manufacturing operations, such as paper and steel production and annealing and baking processes. They're also used for such things as measuring lost time, the flow of liquids or gases, and in time studies on machinery which is stopped and started between operations.

You'll find many other applications described in Bulletin 260. Ask for a copy or for an E/A specialist to call.

The Esterline-Angus Company

No. 1 in fine Graphic Instruments for more than 50 years.

DEPT. N, P.O. BOX 596, INDIANAPOLIS 6, INDIANA

BEACON COAL HAS WHAT IT TAKES

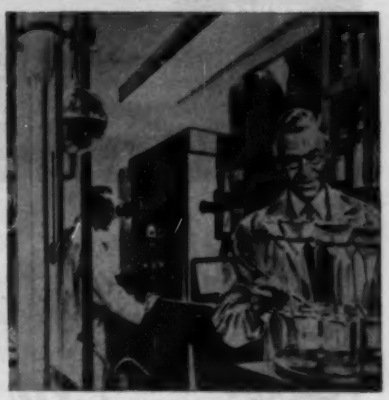
MEN

MINES

CAPACITY

EQUIPMENT

PREPARATION



QUALITY CONTROL

To give the electric utility industry the coal, the assurance, and the service it needs

Next time you write the specifications for the kind of *coal* you want, why not jot down the specifications of the kind of *supplier* you would like to have . . . and see how we measure up!

We have been serving electric utilities for many years, and feel that we know intimately their needs and problems. Our 15 mines provide a variety of coals, and a potential that can deliver up to 15 million tons a year at need. Modern mechanization plus skilled miners equip us to gear production to virtually any emergency you might encounter, and mine location on a number of major railroads gives wide latitude in routing. We maintain close check on quality in our laboratories. Our representatives are men who have made coal their life work and the serving of customers their highest aim. Finally, our past record, if you care to check it, provides complete assurance that you will get the coal you want, when, where, and as you want it.

EASTERN GAS AND FUEL ASSOCIATES

PITTSBURGH • BOSTON • CLEVELAND • DETROIT • NEW YORK
NORFOLK • PHILADELPHIA • SYRACUSE

For New England: New England Coal & Coke Co., For Export: Castner, Curran & Bullitt, Inc.

BEACON COAL

EASTERN GAS AND FUEL ASSOCIATES — BEACON COAL

For more facts circle 272 on Reader Service card, p 109

NEW TYPES

IMPROVED MODELS

COMPLETE LINE

Instantaneous speeds—variations in speeds—average measuring in RPM or FPM—the newest model instruments are described in this new Biddle Bulletin. Handy Selection Chart gives name, range, description and accuracy of all the tachometers in the Biddle line—resonant reed—centrifugal—chronometric—hand and fixed types. Request your copy today

Check Speeds Accurately

POWER TRANSMISSION
LUBRICATION
SLIPPAGE
FRICTION
STRESSES
LOAD
ETC.

JAGABI® TACHOSCOPE
A Speed Counter and Stop Watch in one

JAGABI® SPEED INDICATOR
Speeds Up to 100,000 RPM

JAGABI® TACHOMETER
Speeds Up to 48,000 RPM
Single or Multiple Ranges

FRAHM®

RESONANT REED TACHOMETER
No contact with moving parts—just touch to case of machine or motor housing—read directly in rpm.

METRON TACHOMETER
Activated by flashlight cell. Selection of ranges and scales to 100,000 rpm or 10,000 fpm.

WRITE FOR BULLETIN 35-P

B-503

JAMES G. BIDDLE CO.
Electrical Testing Instruments • Speed Measuring Instruments
Laboratory & Scientific Equipment
1316 ARCH STREET, PHILADELPHIA 7, PA.

moving parts, surfaces which would be reactive with additives. No settling occurred when different dilutions of lubricant were tested for stability at 140 F.—The Alpha-Molykote Corp

Dry-storage hopper activator

23 • Reliable flow of dry materials from any hopper or storage bin is guaranteed by new hopper activator, says maker. Device features mechanical vibrating and pneumatic mechanisms with universal application to any size hopper.

Unit consists of vibrating shaft with attached vibrating arms centered vertically from base to top of hopper. When materials do not respond to vibration, pneumatic aspect takes over, according to maker. Vibrating assembly is mounted on air cylinder which moves up and down through material to help solve hopper problems.—Vibra Screw Feeders, Inc

Just circle key numbers on the Reader Service card, page 109, to get complete product story

Air-cooled electrode holder

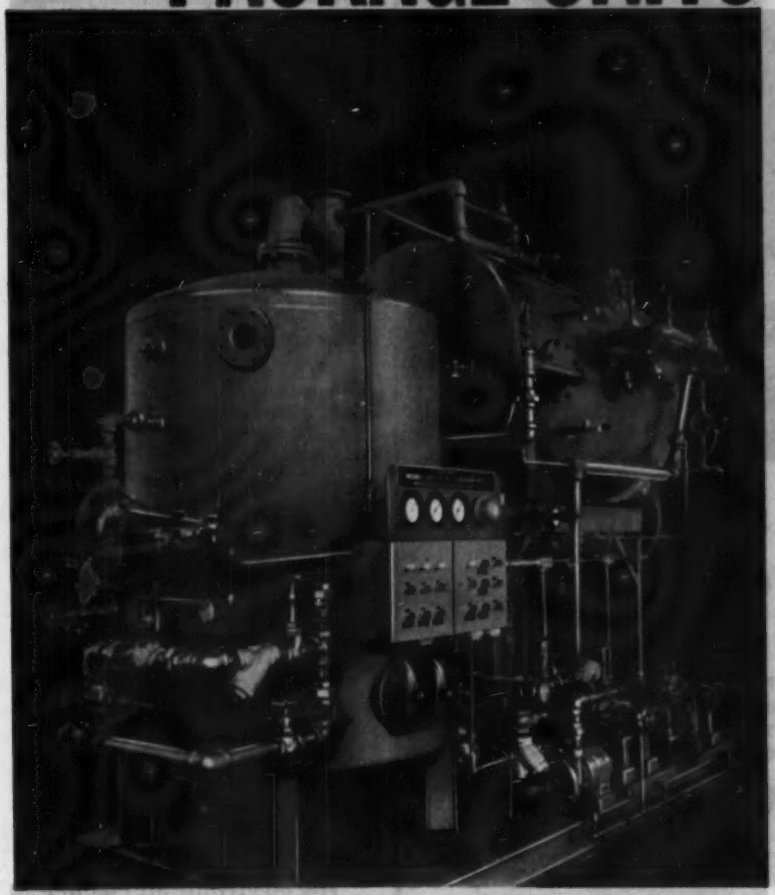
50 • Holder is for heavy-duty metallic arc welding. It will hold electrodes through ⅜-in. dia and is rated 600 amp at 40 v with 60%-duty cycle. Unit is said to let a man weld a full shift without changing holders and to eliminate hazards and complications of water cooling.—J B Nottingham & Company

continued

WICKES

standard

BOILER AUXILIARY PACKAGE UNITS



Save On First Cost • Engineering • Building Space • Construction Time • Operating and Maintenance Cost

Wickes Boiler Co. now offers a packaged system of various compact combinations of DEAERATING FEED WATER HEATERS, BOILER FEED PUMPS, CONDENSATE SURGE TANKS and BLOW-OFF TANKS. Standard units available for steam plants of 10,000 to 100,000 lbs. of steam per hour capacity and steam pressure to 300 PSIG. Information on special units of higher capacities and pressures upon request. Each unit is shop-assembled on a structural steel base, completely piped and wired and equipped with all necessary controls and an instrument panel.

173

Write today for Bulletin 59-1, which gives detailed engineering information on all three models of Wickes Boiler Auxiliary Package Units.

WICKES BOILER CO., SAGINAW 10, MICHIGAN

Division of The Wickes Corporation

WICKES

RECOGNIZED QUALITY SINCE 1854

SALES OFFICES: Atlanta • Boston • Charlotte, N. C. • Chicago • Cleveland • Dallas • Denver • Detroit • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New Orleans • New York City • Philadelphia • Portland, Ore. • Rochester, N. Y. • Saginaw • San Francisco • Seattle, Wash. • Springfield, Ill. • Tulsa

For more facts circle 274 on Reader Service card, p 109

Have You Tried a RIDGID Hex Wrench Yet?

the Perfect Mate for your RIDGID Pipe Wrench!

Six Sizes with Maximum Jaw Openings of 1 1/16", 1 1/2", 1 3/4", 2 1/2", 3 1/2" and 4 1/2" across flats.

Finest of All Adjustable Smooth-Jaw Wrenches

MORE GRIPPING POWER... for all nuts. Puts a wrap-around grip on hexes that just won't slip. Because you're pulling with at least three flat sides at once, you'll never round off shoulders. Works on square nuts, valve packing nuts, unions and gas cocks and flat shapes, too. Smooth jaws won't even mar polished or plated surfaces.

RUGGED CONSTRUCTION... built good and solid. Thin but extra-strong jaws slip into tight places. The first time you use a hex wrench you'll know that here's a wrench you'll use for a long, long time. It's every bit as rugged as your familiar RIDGID Pipe Wrench.

No. E-110 Offset Hex Wrench
Big Jaw, Short Handle for Sink and Tub Drain Nuts—Maximum Jaw Opening—2 5/8" across flats

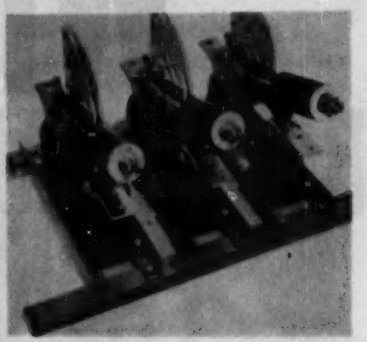
No. E-11 End Hex Wrench
Offset Jaw for Easy Work in Tight Places
Maximum Jaw Opening—1 1/2" across flats.

From experience you know it's easier to work with the best of tools. Order your RIDGID Hex Wrenches from your Supply House today!

RIDGID

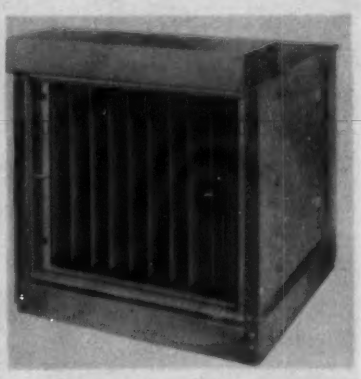
The Ridge Tool Company, Elyria, Ohio, U.S.A.

Equipment news



Load-interrupting switch

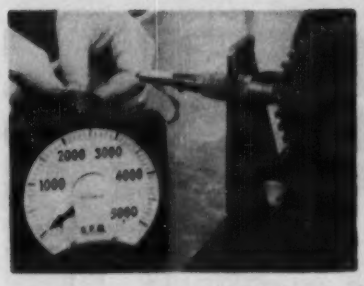
48 • Ac indoor switch is capable of interrupting load currents, says manufacturer. Load interruption is accomplished by means of an auxiliary switchblade. Blade operates in conjunction with main switchblade, breaks an arc drawn between two high-arc-resistant silver-tungsten-alloy contacts in polyester plates comprising the auxiliary switch housing. —Electrical Engineers Equipment Company



H-v electronic air cleaner

43 • Cleaner is based on principle of electrostatic precipitation. Dust particles are charged as they enter unit. Particles are then attracted to and held by the negatively charged collector plates. Construction is a feature: ionizing and collecting chambers are in one compact unit. Lightweight build permits overhead mounting where necessary. — Dollinger Corporation

Begins on page 126



Speed-indicating instrument

36 • New unit is for use with small steam or gas turbines. According to maker, principal advantage of indicating device is that no mechanical connection is needed between device and the rotating shaft. By proper design of the gear or notched shaft, indicator can be adapted to almost any desired rpm range. — Westinghouse Electric Corporation

Just circle key numbers on the Reader Service card, page 109, to get complete product story

Large-dia magnet pulley

17 • Permanent magnet pulleys with diameters up to 48 in. are offered for heavy-duty tramp-iron removal and cobbing applications. Unit is made of barium-ferritic-ceramic magnet material, needs no expensive coils, rectifiers, switches. Pulleys are said to meet performance of electromagnetic types. — Stearns Magnetic Products

Torch, welding-control unit

19 • Contactor interrupts high-amp secondary currents for safety of personnel and equipment. It is designed especially for firm's automatic torch and also for welding equipment. Built to withstand rough use, says maker, it has heavy silver-alloy contacts, rating of 600 amp.—Arcair Company

2 New
RIDGID
Tubing Cutters
Give you Grooved Rollers for close flare cut-offs... no waste! Also, Enclosed Feed Mechanism • Spare Cutter Wheel in Handle •
Fold-in Reamer

RIDGID No. 205 Tubing Cutter

Time-Saving, Slide-to-Size ⅛" to 2⅜" O.D. Capacity

Made of lightweight, high-strength cast aluminum alloy, you'll find these new RIDGID Tubing Cutters extra handy. Slight push on handle of large-size-range RIDGID No. 205 snugs cutter wheel against tubing . . . locks it in position until released. Feed screw fully protected and enclosed . . . always feeds into tube with easy handle turn . . . can't jam with chips or dirt. Wheel gives quick, clean cuts of copper, brass, aluminum tubing and thin-wall conduit . . . no burr. Grooved rollers give easy flare cut-offs without tubing waste. Tubing always turns freely on 2 of 4 Rollers. Rollers smooth tubing ready for soldering. Fold-in reamer always handy. Spare cutter wheel in handle. Wheel for plastic and aluminum pipe available for No. 205 only.

Conform to Fed. Spec. GGG-C-771b Type II—Class I—enclosed feed mechanism

RIDGID No. 105 Tubing Cutter

Protected Feed Screw
Always Easy-Turning
⅛" to 1⅛" O.D. Capacity

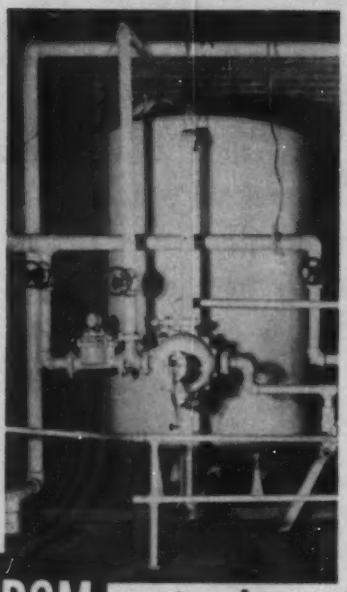
To save time and tubing, order these new RIDGID Tubing Cutters today!
Your Supply House has them!

RIDGID

The Ridge Tool Company, Elyria, Ohio, U.S.A.

For more facts circle 276 on Reader Service card, p 109

Elgin makes it !



FROM a simple zeolite water softener

TO a complex automatic deionizer

-and anything else in between

A firm like Elgin that can give you *anything* you need is obviously the firm that can give you the *right* thing.

Exactly the right thing! . . . the kind of equipment and installation that will give you maximum results at lowest cost . . . the kind of set-up that can only be assured by more than 50 years of intensive specialization in the difficult field of water conditioning.

Yes, a difficult field; a field with too many complexities, too many pitfalls, for the "Johnny-come-lately". And this is just as true of the simplest equipment as of the most complex. The equipment may be simple, but anyone who knows the water conditioning field will tell you that the knowledge going into it is far from simple.

The Elgin installations above are poles apart—in form, in purpose, in cost. But they have one thing in common: Thanks to Elgin know-how, they are the best of their kind. And so is "everything in between" when it's Elgin!

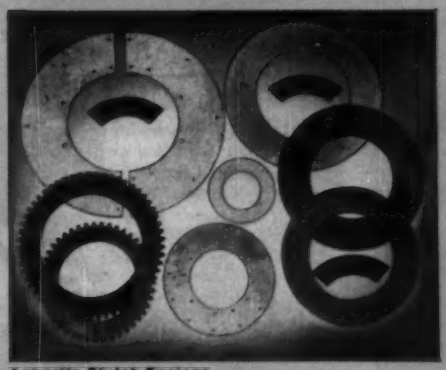
Write for Bulletin 615 covering the scope of Elgin experience. Our nearby representative can put Elgin experience to work on your specific requirements from simplest to most complex.

ELGIN
WATER CONDITIONING
SINCE 1908

ELGIN SOFTENER CORPORATION
130 North Grove Avenue, Elgin, Illinois
Representatives in Principal Cities • In Canada: G. F. Sterne & Sons Ltd., Brantford

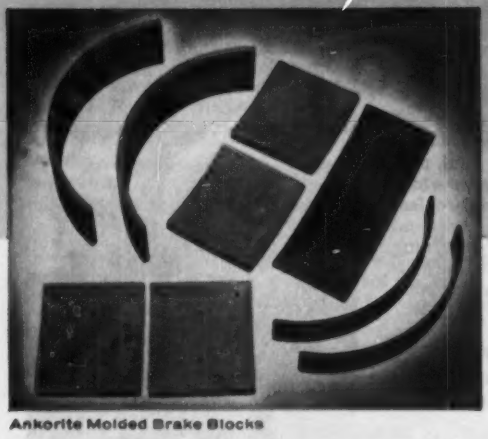
SOFTENERS ION EXCHANGERS FILTERS DEIONIZERS DEALKALIZERS CLARIFIERS DEGASITORS DEAERATING HEATERS

Ankorite Woven Brake Lining



Ankorite Clutch Facings

Busy Engineers Specify Dependable...



Ankorite Molded Brake Blocks

ANKORITE FRICTION MATERIALS

It pays dividends in time and money to select brake linings and clutch facings that are engineered to meet the toughest of service demands. In this class, Ankorite Friction Materials are second to none. For example:

ANKORITE BRAKE LININGS insure smooth safe stops . . . will not score your drums. They last longer—speed braking operations. Heavy duty and lighter duty types are available for all uses—dry or in oil, indoors or outdoors.

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STEAM TURBINE-GENERATORS

By N. K. Halsteen, Project Engineer, Brown Boveri Corp.

BROWN BOVERI

In 1901, Brown Boveri built the first steam turbine installed on the European continent. This turbine was also the world's largest. Since then, the company has made many basic contributions to turbine design and has built more than 5300 steam turbines for generating electric power and for driving blowers and compressors.

Brown Boveri steam turbine-generators include these types and sizes:

Condensing units offer highest efficiency, lowest steam consumption. All ASME Preferred Standard sizes. Single-shaft units to 350 mw. Cross-compound units to 500 mw and up.

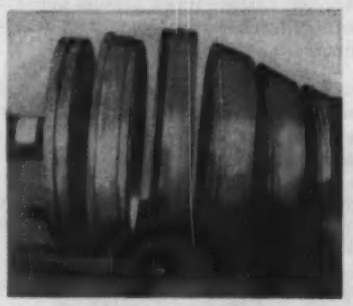
Back-pressure units are rated at 500 to 30,000 kw and supply exhaust steam at 20 to 350 psia for low-pressure condensing units or for process.

Extraction-condensing units are rated at 1000 to 100,000 kw. Extraction steam at 7 to 15 psia is used for process and for heating water in municipal heating systems.

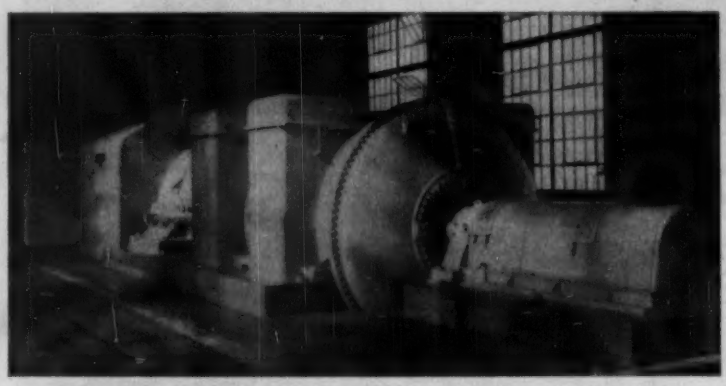
Sectional rotors

Brown Boveri turbine rotors are made of forged sections welded together at the rims. This construction offers advantages over one-piece rotors: The relatively small size of each section ensures a more uniform forging and allows more thorough inspection. Sections with flaws are rejected and replaced virtually eliminating patching often required to salvage large one-piece forgings.

Asymmetries are cancelled out by the random positioning of adjacent sections. The low weight of a hollow, sectional rotor provides fast warm-up and rapid, uniform heat distribution in service. The sectional design eliminates axial stresses. Completed rotors are given ultrasonic tests and stress-relieving heat treatment. *No explosions or other serious failures have ever been experienced with Brown Boveri sectional rotors.*



Sections of a steam turbine rotor before welding. Welding is done automatically by an inert-gas process.



A Brown Boveri 30/33 mw Preferred Standard unit at Greenwood Mills, S. C.

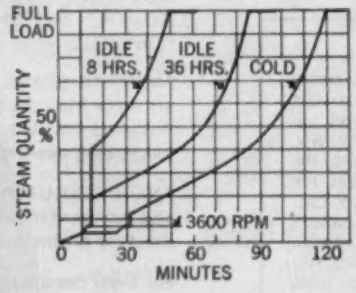
Hydraulic governing system

The Brown Boveri all-hydraulic, governing system uses no mechanical links and thus eliminates joint play or thermal expansion of links which may cause "hunting." Synchronization is quick, simple. On high-temperature reheat units, the governing system is separate from the lubricating oil system and uses a non-combustible fluid.

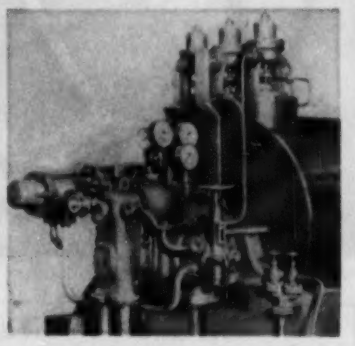
Fast start-up, flexible loading

The low weight of the rotor, lightweight casings and special flange-heating systems reduce temperature differences in the machine to a minimum . . . allowing fast and cold starts, fast changes in load and fast shut-downs without dangerous expansion differentials. Close radial tolerances can be maintained.

These advantages, together with simple synchronizing, are particularly useful where frequent start-ups are required . . . as for peaking.



Starting schedules for a large multi-cylinder reheat turbine . . . illustrating how quickly temperatures in the machine are equalized.



Brown Boveri linkage-free pressure oil governing system. Turbine may also be started and shut down with a single handwheel.

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Brown Boveri maintains installation crews and service shops in the U. S. and Canada . . . also working agreements with Todd Shipyard Corp. and National Electric Coil Co. whose shops can rebuild or repair the largest turbines and generators now in use and who have an outstanding record for fast, efficient service.

BROWN BOVERI Brown Boveri Corp., Dept. P3, 19 Rector Street, New York 6, N. Y. Agents in 27 U. S. cities.

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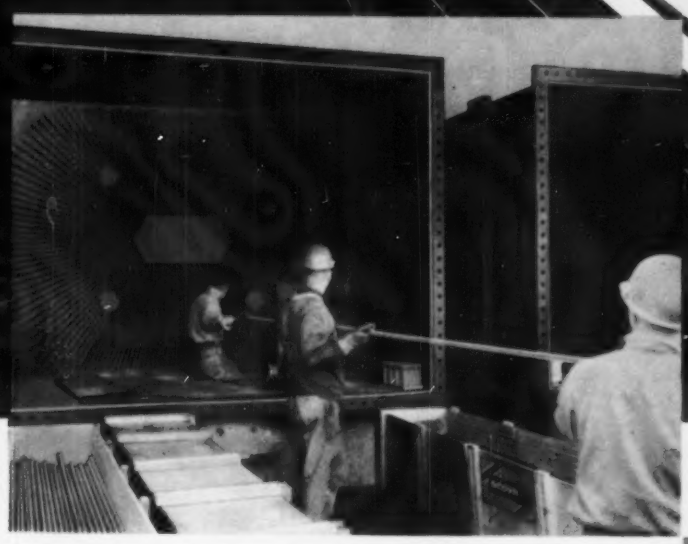
YANKEE ATOMIC



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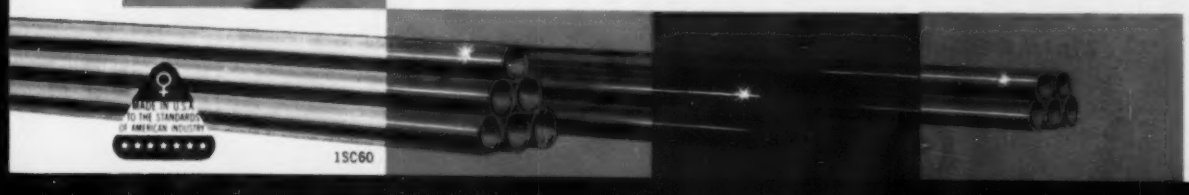

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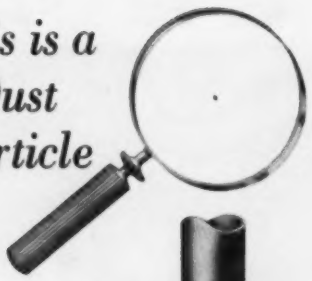
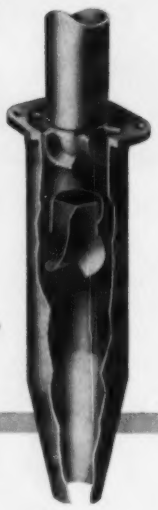
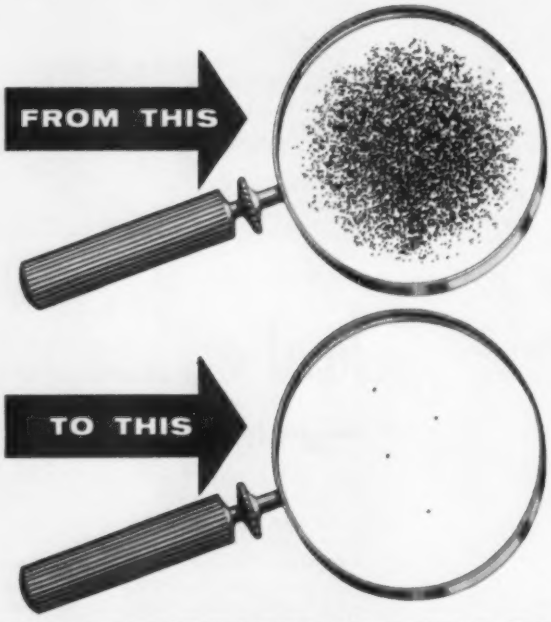


This is a Cyclo-trell Dust Collector →



The Cyclo-trell Dust Collector Cleans Gas with these Dust Particles...



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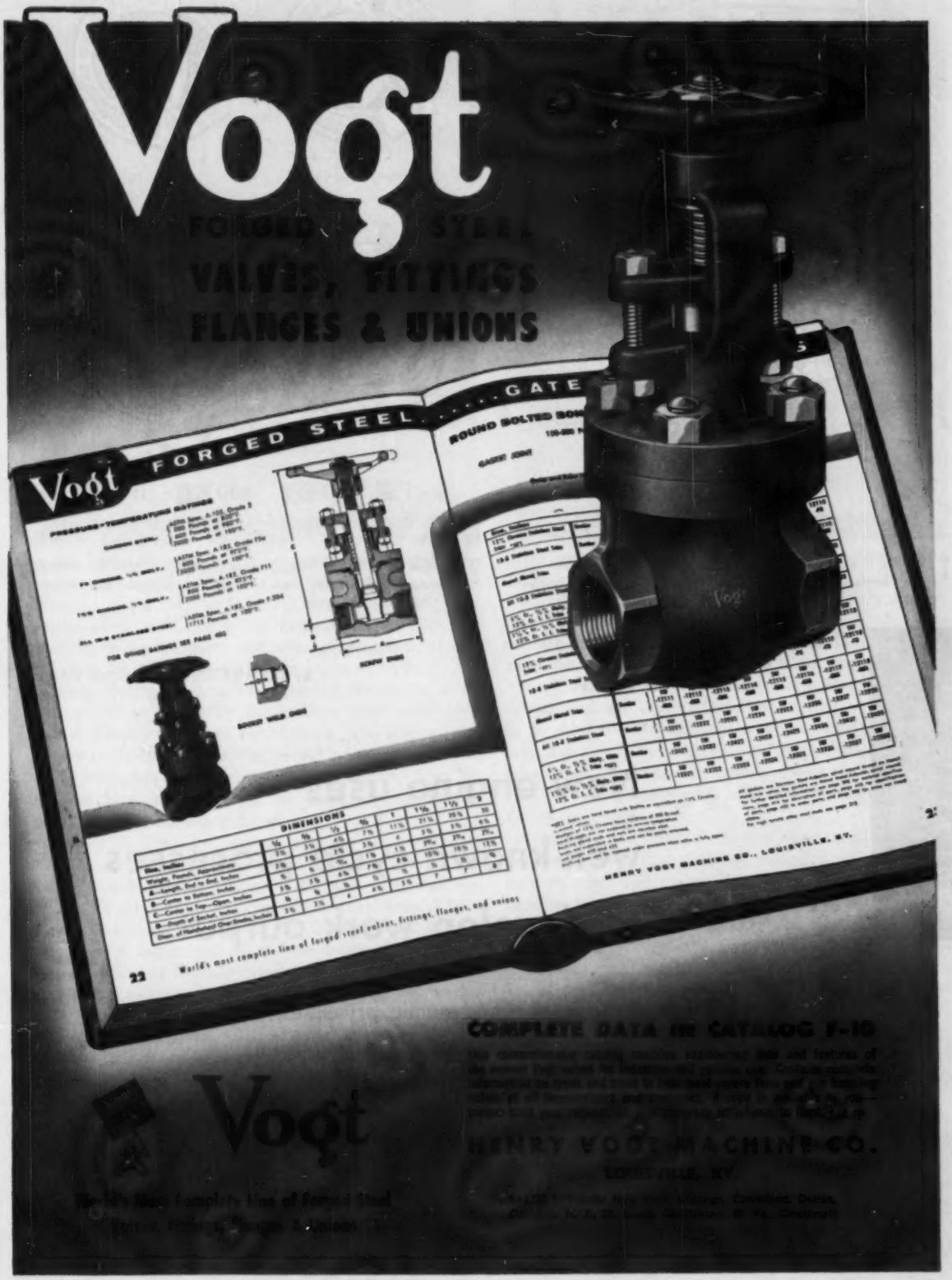

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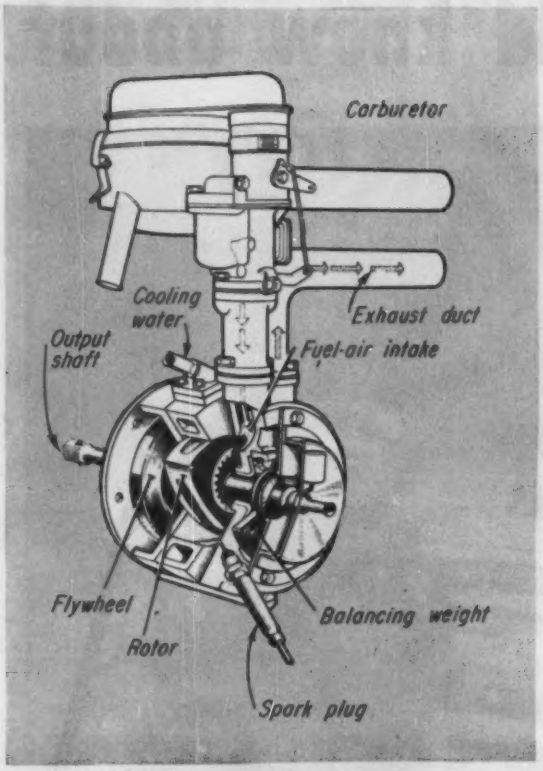
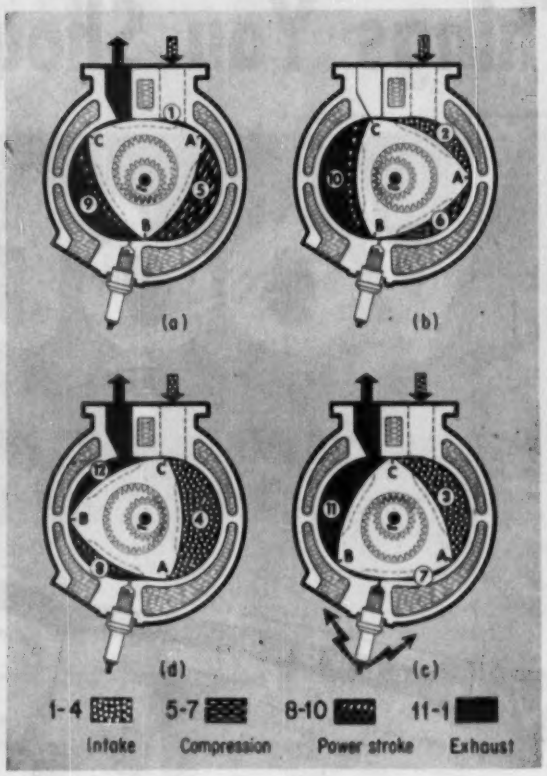


1 Rotary engine has two moving parts—rotor and output shaft, may be made to work on diesel cycle by using fuel injection



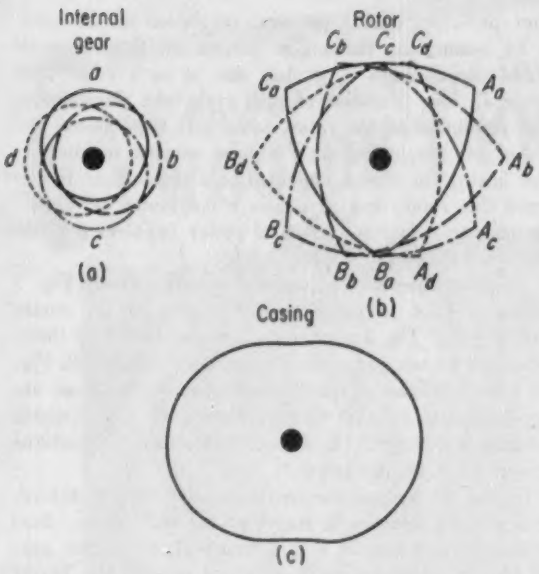
2 Engine rotor turns through planetary path guided by casing, meshing with output shaft through internal gear and pinion

THERMO REFRESHER NO. 36

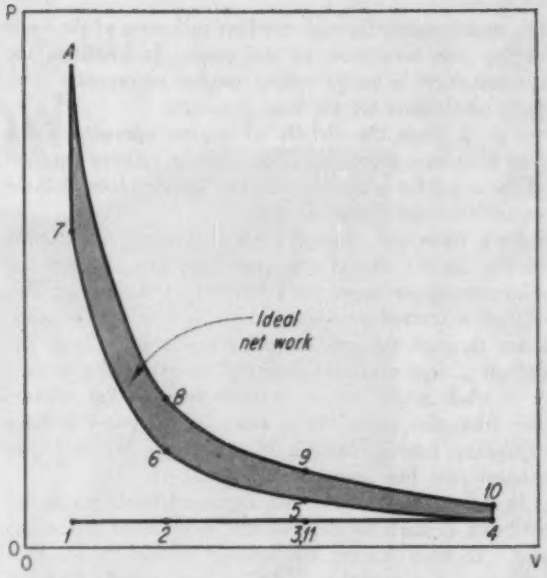
By B G A SKROTZKI, Associate Editor

New engine uses well-known cycle processes to develop work output

- Basic thermodynamic principles do their work in an advanced mechanical arrangement
- Advantages offered by clever arrangement include compactness and light weight per unit output
- Development centers on proving practicality of design rather than the thermodynamic cycle



3 Separate drawings of internal gear and rotor outline emphasize eccentric path of rotor about center of output shaft



4 Ideal P-V diagram shows conventional thermodynamic cycle engine uses; numbers key cycle to rotor position in Fig. 2

Before going on to the subject of vapor cycles next month, let's study a rotary 4-cycle engine recently announced by the NSU Company of Germany and Curtiss-Wright Company of the U.S.A. Thermodynamically this engine offers nothing new—it uses the intake, compression, ignition-expansion and exhaust processes of the standard reciprocating engine we know so well.

Reciprocating engines have proved themselves overwhelmingly as shown by the millions used world-wide today. Despite this good record there have always been efforts to design engines that would minimize the wide swing in forces that i-c engines must handle. Also, i-c engines have many moving parts, all needing adjustment and maintenance at times.

Efforts to make gas engines that do not reciprocate date as far back as 1699. James Watt tried to build a rotary steam engine between 1782 and 1786 but was licked by the sealing problem. Many unsuccessful tries have been made since then, but the new NSU-Wankel engine now appears to be on the verge of feasibility. Felix Wankel of Germany invented the engine.

Fig. 1 shows a cutaway view of the engine with carburetor and exhaust line on top. Fig. 2 shows internal arrangement of rotor, casing, ports and output shaft.

First let's study arrangement of the engine, Fig. 1. Engine handles three separate charges of working fluid simultaneously, all undergoing different processes at any instant. Feature of the engine is only two moving parts, (1) a triangular-shaped rotor having an internal gear and convex sides and (2) an output shaft geared to the rotor. Center of the output shaft is fixed, but rotor turns through a planetary path and has no fixed center.

The three apexes of the rotor always rub over interior of the casing and fix rotor's path. Technically the outline of the casing is a double epitrochoid. Sealing strips at the apexes divide the space between rotor and casing into three compartments.

As the rotor turns, these compartments vary in volume, being at a minimum when any one of the sides parallels the bottom or top of the casing, and at a maximum when any of the sides stands about vertical.

Since rotor's center of gravity turns about the fixed output shaft the rotor is unbalanced. Balancing weight on the shaft counterbalances the rotor's centrifugal force. Like a reciprocating engine, this engine develops only intermittent and varying turning forces, so it needs a flywheel to store energy for brief rapid bursts to be used during compression.

The gear ratio makes the output shaft turn three times as fast as the rotor, helping minimize friction losses between rotor and casing. Engine in Fig. 1 has a carburetor to prepare fuel-air mixture for entry to the engine through the inlet port, at top. The exhaust port, to the right of the inlet port, carries off the burned expanded gas. Spark plug in the lower part of the casing does its usual ignition duty. Cooling-water jacket surrounds the entire casing.

Elimination of a crankshaft and piston rods makes this a compact engine, reducing weight to about 1 lb per hp; designers expect to cut this to ½ lb per hp eventually.

Curtiss-Wright mentions that engine temperature runs as low as 300 F and the engine develops one bhphr for 0.45-lb gasoline. NSU says that special treatment of the casing-wall metal resists heat developed in the ignition area and helps maintain a good seal between the three compartments formed by rotor and casing.

Processes. Any one charge of air-fuel going through

the engine passes through the four processes of the cycle during one revolution of the rotor. In contrast, the crankshaft of a reciprocating engine makes two complete revolutions for the four processes.

Fig. 2 gives the details of engine operation. The four diagrams shown only cover about 120-deg rotation of the rotor but show all processes taking place as three separate but simultaneous series.

Let's trace one charge passing through the engine. In Fig. 2*a* the charge *1* is just beginning to enter the minimum upper space between rotor and casing. Tail end of a burned previous charge is leaving the same space through the exhaust port, to the left. In *b* the fuel-air charge continues entering the expanding volume at *2*, while seal *C* is just starting to close the exhaust port from this space. In *c*, since the volume continues expanding into *3*, fuel-air keeps flowing in; at *C* the exhaust port has been completely cut off.

In *d* the intake volume has expanded to its maximum at *4* and *C* starts to close off the space from the intake port. To keep tracing this charge of fuel-air we skip back to *a*, but note that seal *C* is now seal *A*. Keeping this transition in lettering in mind we see that our fuel-air charge is now being compressed in the diminishing volume *5*, seal *A* having cut it off completely from the inlet port.

In *b* the fuel-air charge continues being compressed by the shrinking volume of the space at *6*. In *c* the charge has now been squeezed into the minimum volume at *7*. Shortly after the rotor face *AB* passes midpoint of its lower position the spark ignites the fuel-air charge. The heated gas now exerts a sharply rising pressure on the rotor and casing. Since the rotor is in an unbalanced position about the output shaft it exerts a net force on the rotor face *AB* to turn the rotor in a clockwise direction.

In *d* the expanding volume at *8* allows gas pressure to change as it does work on the rotor face *AB*. In this position the gas has more leverage so it exerts greater turning torque on the rotor face.

To continue tracing the processes we again go back to *a*. Again we get a letter transition and seal *A* now becomes seal *B*. In *a* the hot gas continues working on the turning rotor as it expands to volume *9*. Gas has stopped burning and the pressure starts dropping because of increasing volume and no heat input—in fact, water cooling contributes to pressure drop as in a reciprocating engine.

In *b* gas expands into maximum volume at *10* and seal *C* is about to uncover the exhaust port. In *c* the seal *C* has completely uncovered the exhaust port and the gas has quickly blown down to about atmospheric pressure as it leaves through the exhaust duct.

In *d* the diminishing volume at *12* forces out the remaining burned-gas charge and seal C is beginning to uncover the inlet port. Again returning to *a* we have just completed one revolution of the rotor and find seal *C* is again seal *A* (to accommodate the letter transition). The minimum volume above face *CA* has now forced the tail end of the burned gas out of the casing at about atmospheric pressure and this space is now receiving its next charge of fuel and air, ready to repeat the cycle of four processes during the next revolution of the rotor.

To summarize, the engine carries on three separate series of processes or cycles, one at each rotor face. Since all four processes of each cycle take place during one revolution of the rotor, rotor gets three power impulses per revolution, each impulse varying in intensity and lasting for almost one-third of a revolution. In one sense this rotary engine equals a 6-cylinder 4-cycle reciprocating engine, in terms of power impulses per revolution of the output shaft.

Engine shape. Symmetrical appearance of Fig. 2 makes it hard to judge the movement of the rotary engine parts. Fig. 3 reproduces parts of Fig. 2 by themselves so we can judge their shape and motion. In Fig. 3*a* four positions of the internal gear of the rotor are reproduced in relation to the output-shaft center which remains stationary. The letters correspond to positions shown in Fig. 2*a*, *b*, *c* and *d*.

In Fig. 3*b* we see the corresponding rotor positions. Notice the difference in travel of the seal points. Seal *C* has a much shorter travel than seal *A* for this particular part of one revolution (about one-third). Travel from C_a to C_d is much slower than travel from A_a to A_d since they each take place in the same time interval. For constant-output shaft speed the speed of seals' linear travel will be the same as each traverses the same part of the casing wall. This shows the complex planetary path the rotor takes during each revolution.

Fig. 3*c* shows the symmetrical layout of the casing interior wall. This shape, called a double epitrochoid, must be machined closely to maintain contact with the seals on the rotor. Critical question of success of the engine depends on how well the casing wall can maintain its shape under the stress of changing gas pressure and temperature.

Original engines using this principle have been lubricated by mixing the oil with the fuel, as in a 2-cycle engine. But experience shows this makes it impossible to have a clear exhaust from the engine. Air-pollution agitation makes it inadvisable to promote an engine with this fault. NSU Company report that they are developing a forced-lubrication system to deliver oil to the seals at the point of friction, keeping exhaust clear.

Engine cycle. Fig. 4 shows how the engine would run on an ideal cycle on P-V coordinates. For reciprocating engines we could draw the equivalent cylinder volume and corresponding piston position below the volume axis. We can't do this for the rotary engine, but we can correlate it by position numbers.

The numbers on the cycle of Fig. 4 correspond to the numbered volumes and positions shown in Fig. 2. Fuel-air induction takes place through *1-2-3-4*, next compression of the fuel-air charge through *4-5-6-7*. Ignition of the mixture takes place at *7* for a sharp pressure rise to *A* (not shown on Fig. 2). Then expansion and work take place through *A-8-9-10*. Most of the gas blows out of the cylinder as the exhaust port is uncovered after position *10*. Then the rotor squeezes the rest of the spent gas from the compartment through *10-11-12-1*. Actual engine cycle, of course, differs from this ideal because of irreversibilities and heat transfer.

Next month we start studying vapor thermodynamics.

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For rotary and centrifugal shafts, valve stems, and reciprocating rods, rams, and plungers, Garlock LATTICE-BRAID* Packings are engineered for longer packing life. They employ a through-and-through braiding construction. As illustrated, each strand passes diagonally through the packing at a 45° angle. This unique construction makes a completely unified structure, resulting in greater strength. Since there is no single outer braid to wear through, Garlock LATTICE-BRAID wears far beyond the limits of ordinary packings. Catalog AD-131.

For rotary shafts, Garlock PK MECHANIPAK Mechanical Seals are easy to install and maintain. They are completely self-contained . . . no parts to put together. Rotating portion simply slides onto shaft; stationary portion positions quickly. Once installed, further adjustment is unnecessary. No parts of the seal move on the shaft or sleeve, eliminating wear on the shaft. Available in shaft sizes from 3/8" to 3" for shaft speeds up to 2000 f.p.m. and higher. Catalog AD-150.

Take advantage of Garlock's years of experience with sealing problems of all types. Call your local Garlock representative at the nearest of Garlock's 26 sales offices and warehouses throughout the U.S. and Canada. Or, write for the catalogs indicated.

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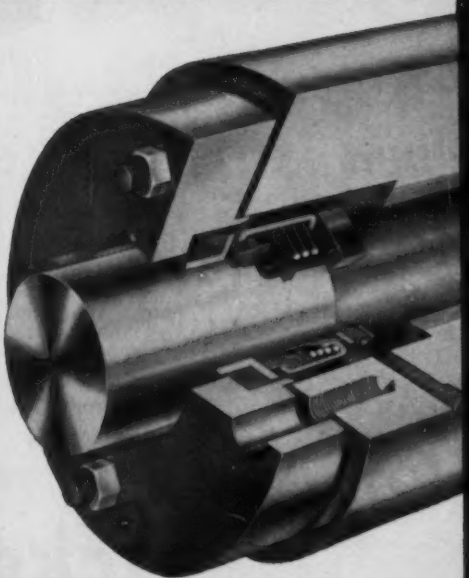
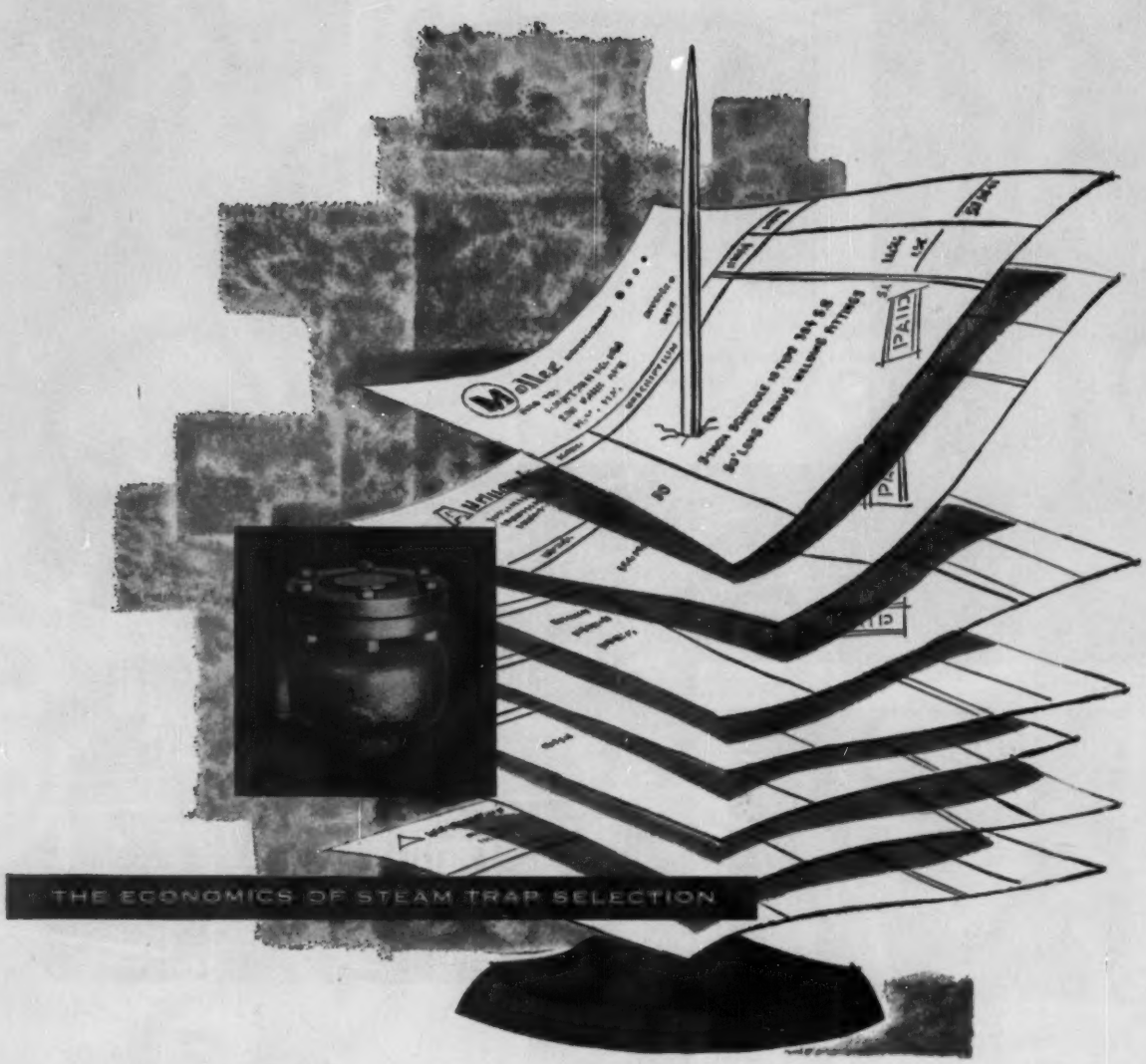
CHEVRON Packings can be applied against water, steam, oil, gases and chemicals to 600°F.

LATTICE-BRAID Packings are used to 700°F in water, steam, oil, gasoline, inert gases, acids, caustics, other chemicals.



PK MECHANIPAK Mechanical Seals operate at temperatures to 212°F, pressures to 150 p.s.i. in water, oil, alcohol, mild acids and solvents.



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"The tall brick stack was belching heavy black smoke and soot, like Vesuvius during the last days of Pompeii," burbled Marmy

Marmy's coughing boilers

"Why not standardize OE exams?" asked George Edwards in Dec 1959 POWER. I agree! But *who* is going to carry the ball? I thought I'd started the ball rolling when I surveyed the American and Canadian requirements, then boiled the bushels of legal double talk down to a 32-p article in 1950. Far as I know, that had never been done before. But what happened? NOTHING! Not even the NAPE, whose job I felt it was to spearhead such a movement, even bothered to let me know that I had made a contribution. I'm not squawking, but I was amazed to find myself crying so alone in the wilderness.

Now an editor must lead the thinking of his audience. His paper must breathe with the excitement of its field . . . the excitement of its events, ideas, controversies and crusades. But it turned out to be a 1-man crusade.

Being stubborn, I raised my faltering voice again in 1959 by making a second survey to see what progress, if any, had taken place in nine years. One quick look will tell you kind readers how ridiculous most of the requirements are, especially in this age of supercritical pressures and nuclear energy.

So now George thinks it's high time to give the plant operators some prestige. OK! But you can't let George and me do it all. It's up to all of you with a stake in the power-services field to at least stand up and be counted. Anyway, when I read George's article I thought I'd get one more opinion. You guessed it. Marmaduke Surfaceblow's . . . that free-wheeling hard-working hard-playing cantankerous consulting engineer.

So my shipmate here at POWER, ex-boiler-inspector Associate Editor Bob Bellas and I barged into the Bent Propeller Bar today, hoping to be showered by our hero with a few words of wisdom. Yup, the great man was there, holding down the north end of the long bar as usual. All 6 ft 4 in. of him, with the gray bowler perched rakishly atop his dome. Just leaning on the bar, staring dreamily at his bottle of Sandpaper Gin, completely oblivious to the noisy seafarers around him.

"What this country needs," I began meekly, now that I was in the presence of this world-renowned engineer, this outstanding personality who has solved more baffling problems than any man or beast, in every corner of the globe . . . "what this country needs," I repeated, fearing he didn't hear me, "is standardized exams for oper-

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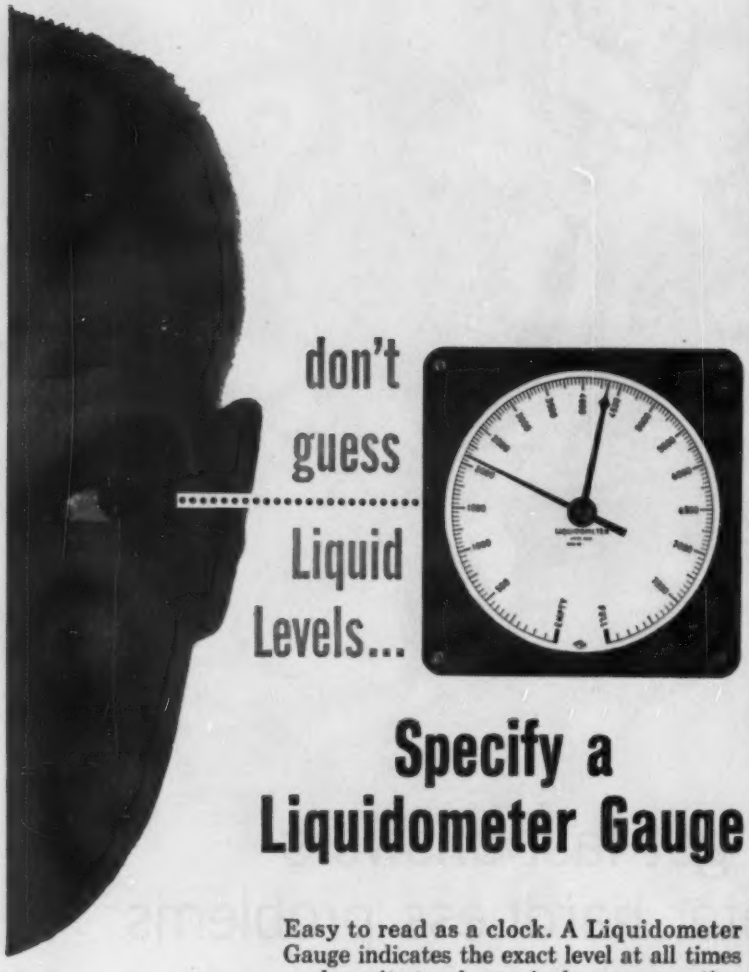

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Marmaduke

Begins on page 158

ating engineers. With my new books as a basis, examiners can now test ..." but that's as far as I got.

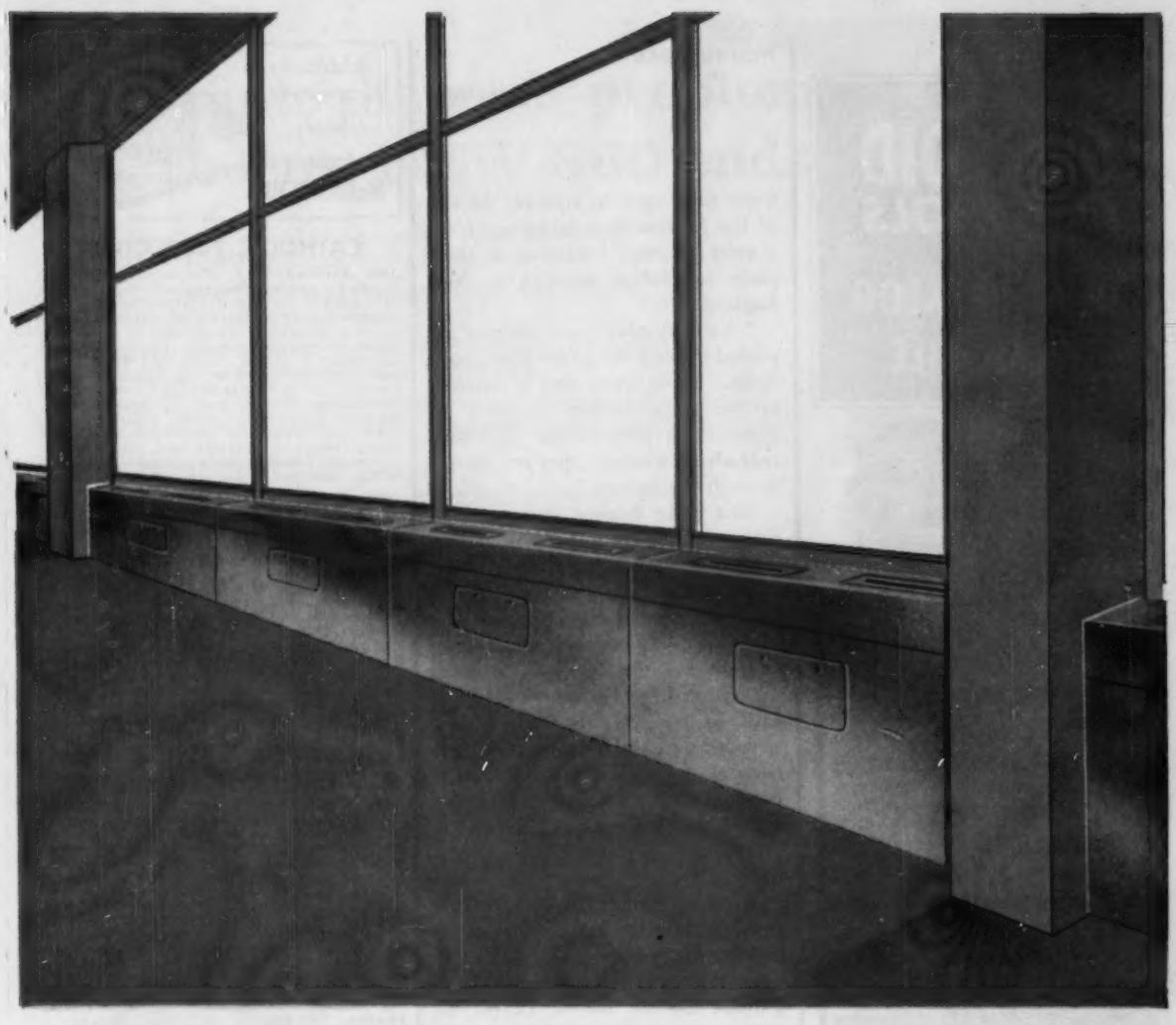
"BILGEWATER on examinations," suddenly roared Marmy, coming violently to life. "I'll tell you educated air-polluters how I tamed a flock of belching boilers. And all I did was throw their sacroiliac back into joint, straightening out their nervous system."

That did it. Bob and I grabbed a ringside seat and ordered two short beers. The other cash customers put down their refreshments and turned admiring but somewhat bloodshot eyes toward that explosion. Marmy leisurely ballasted his deeps with a noisy gurgling sound from the bottle before him, then turned towards his audience.

"Back in 1926," he burbled in his foghorn voice, "I was chief engineer of the collier *SS Roanoke*. We shuttled between Chesapeake Bay and Boston. One blustery March morning, just as we tied up at the Boston coal docks, who should come up the gangplank but my old shipmate Spike Wilcheck. Spike and I had been shipmates aboard a west-coast lumber schooner years before.

"Spike said he had just driven up from Brockton, where he was chief utilities engineer in a big shoe factory. 'You should see our rejuvenated plant,' he chortled. 'She's a sweetheart, got more pep than a monkey with goat glands. I got the job two years ago because of my oil-burning experience aboard ships. While we were converting to oil, I sold management on automatic combustion controls. Fact is, we changed her over to automatic last month. And she works like a voodoo charm. Nothing like those neurotic Scotch boilers you and I shovel-fed all over the Pacific.'

"We shoved off soon as I'd turned in my engine-department abstracts to the port engineer's office on the dock. As we drove down to Brockton, Spike brought me up to date. Said that new management took over a few years before, started out with a modernization program. The top brass were so tickled with their revamped factory and power plant that they



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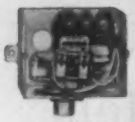

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New SP-DT low pressure (instrument air) control. Small in size, light in weight. Provides any of following operations: SP cut-in high; SP cut-in low; or SP-DT operation. Two operating ranges 1 to 20 and 1 to 30 psig. External adjustments, visible dial and visible circuit position. See catalog No. 860

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ASK FOR CATALOG NO. 860

THE MERCOID CORPORATION
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Marmaduke

Begins on page 158

threw them open to visitors. As one of the jazziest shoe factories in the country, it was becoming a show place for rubber-neckers to New England.

" 'Each Monday noon, visitors are piloted through the power plant,' said Spike. 'From there they're lunched in the large factory cafeteria as guests of the corporation. Then as a red-carpet windup, they're guided through the factory.'

"But Spike thought visitors to his power plant were a No.-1 headache. He was a hard-slugging chief whose main interests were his boilers, turbines, pumps and gages. Besides, the place was crammed with machinery and visitors distracted him. Spike worried that someone would get hurt. Like so many chiefs, he was too wrapped up in his everyday headaches to worry about public relations. He just wanted to be forgotten so he and his men could squeeze every drop of power out of every Btu. 'After all, that's why I was hired,' he grumbled.

"Spike told me that two sets of oil burners were used in the boilers. For automatic operation, steam-atomizing burners did the job at 120-psi oil and steam pressure. Oil-heater relief valves were set for that pressure. But for manual operation the mechanical atomizers operated up to 300-psi oil pressure.

"Soon as we dropped anchor at the factory, Spike and I navigated into the power plant. It was about noon and several dozen characters were wandering about—an office clerk had them in tow. The plant sparkled. Everything was spit and polish, almost like a ship's plant. I noticed some people ogling the boilers; others were gawking at the feed pumps. A few over on one side were rubber-necking at the control panels. One or two oddballs were just drifting around like derelicts, a hazard to navigation.

" 'You should have seen this joint two years ago,' Spike boasted, throwing out his chest. 'I'll bet it hadn't been painted since the Pilgrims landed at Plymouth Rock down the bay. But soon as I started sparking

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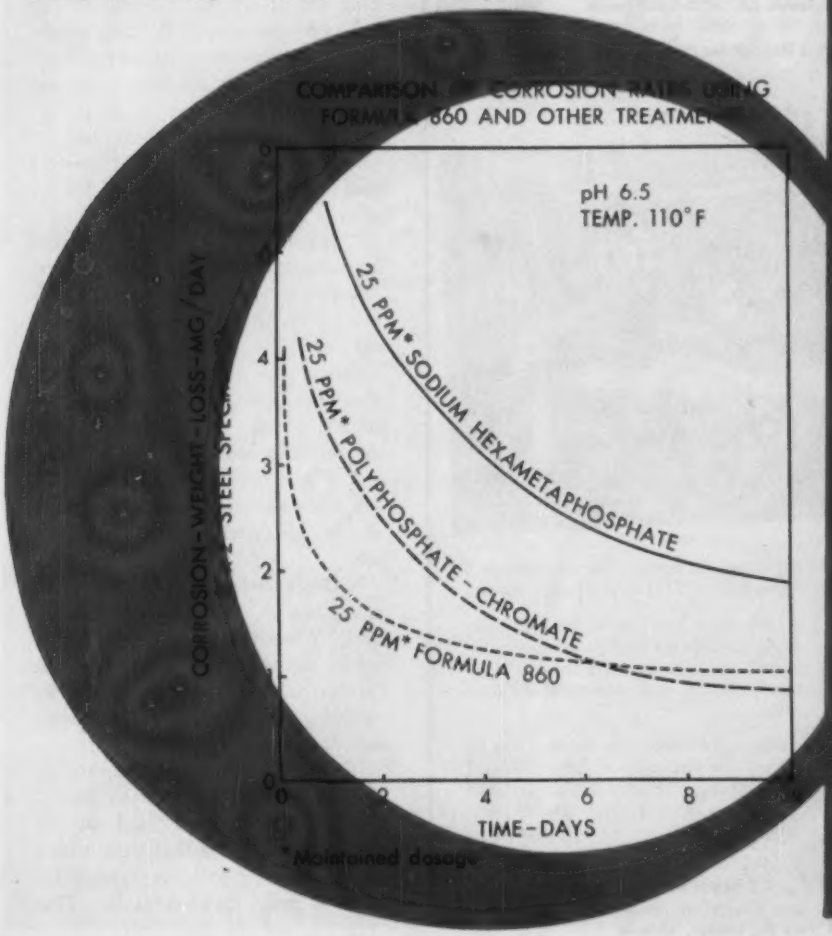

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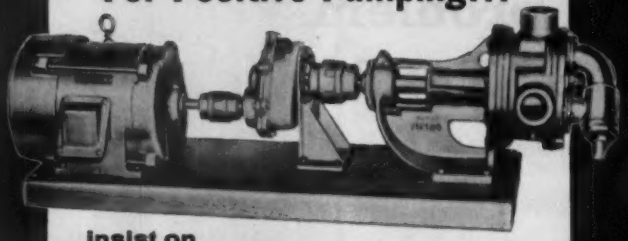

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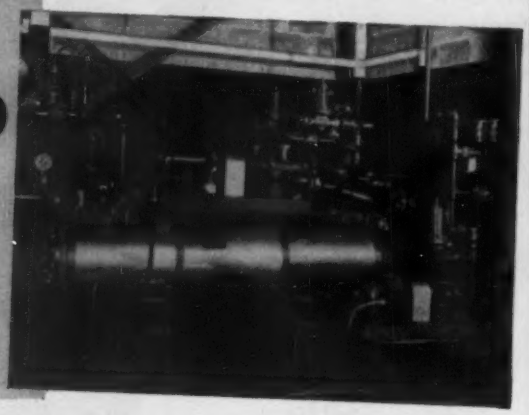

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EC-507

For more facts circle 296 on Reader Service card, p 109

Marmaduke

Begins on page 158

her up the big shots got interested. Now they beat the drums for every important visiting fireman who staggers to New England.'

"After I'd followed Spike around the boiler room, we steamed over to the factory cafeteria for some chow. But just as we beached our trays of grub at a table the super's secretary came slogging in. 'Better get over to the plant in a hurry, Chief,' she trilled excitedly. 'City Hall's burning up the boss's telephone. Something about smoke.'

"Spike and I popped up from the table and plowed through that cafeteria heading for the boiler room. Then we saw it. The tall brick stack was belching heavy black smoke and soot, like Vesuvius during the last days of Pompeii. Smoke was also shooting out the boiler-room doors and windows. An operator came running out of the place, coughing like a backfiring engine. Barging inside, I saw two operators galloping from one machine to another, coughing and yelling.

"'The assistant's looking for ya, Chief,' yelled someone hot-footing past us as Spike and I headed for his office.

"'It's City Hall, Chief,' croaked his assistant, handing Spike the receiver soon as we got inside his office. With that the assistant rushed out of the glassed-in room and slammed the door. I scooted after him, heading for the combustion-control panel. Spike banged down the receiver and hung on my stern.

"'What's going on?' I heard him ask his assistant, who was squinting at the instrument board alongside me.

"'Don't know, Chief,' the assistant answered, wiping smoke from his eyes. 'When the fireman lit off after lunch the oil-relief valves on the heaters started popping. Then we started getting flarebacks. She's been belching smoke ever since.'

"'I thought we needed more draft without even looking at the panel,' coughed the assistant. 'So I speeded up the blower. But that only caused smoke and soot to blow through the furnace and duct crevices. That

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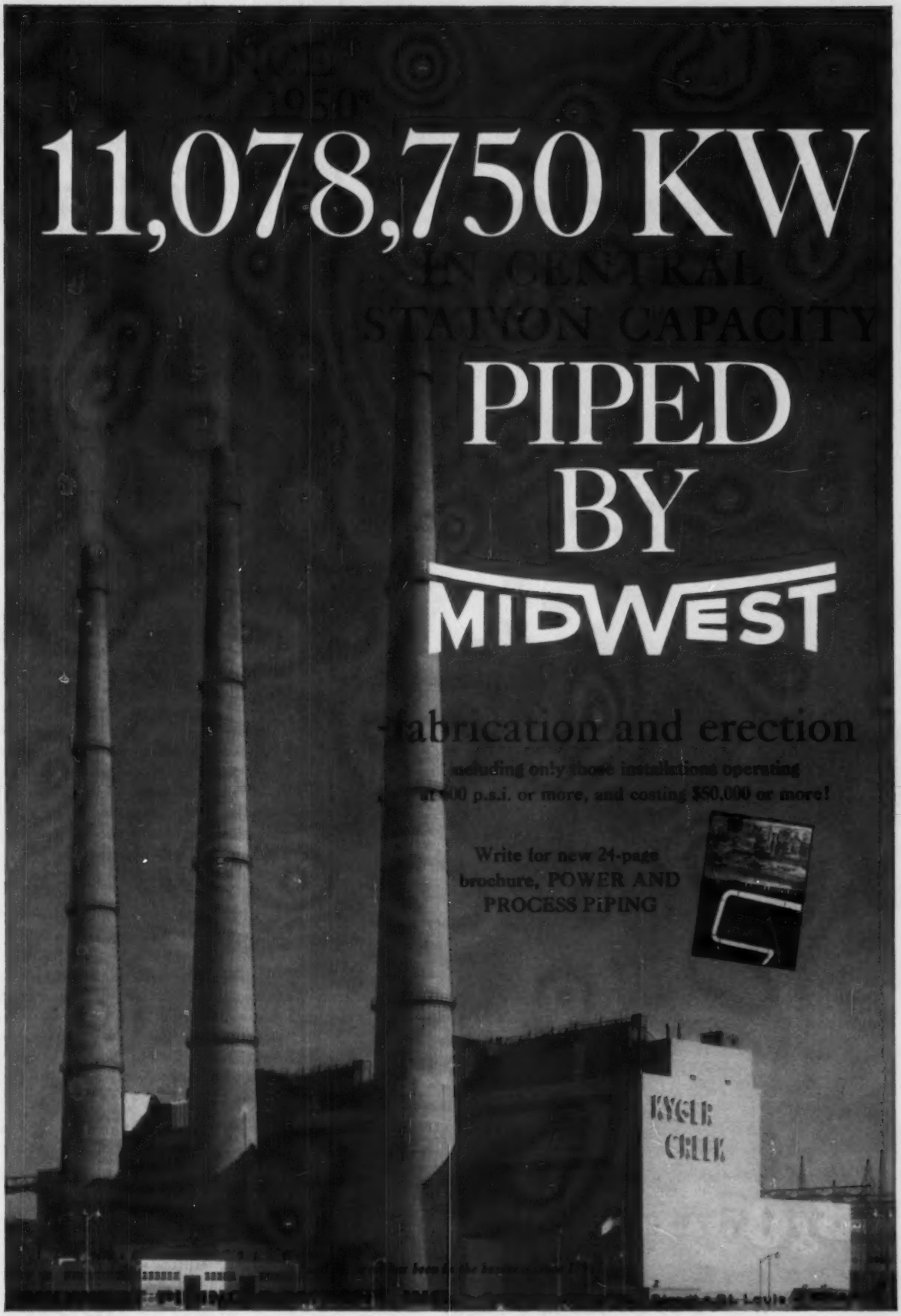

Marmaduke

Begins on page 158

smoke indicator is so damn black I can't see anything.' That was all I wanted to hear.

"I groped over to the loading valve I had looked at when touring the plant before. Sure enough, that valve was on hand operation. So I yanked it back to automatic position. Like a miracle, the smoke cleared up instantly as the boilers began purring like well-fed kittens.

" 'Well I'll be a mermaid's mother-in-law,' yelled Spike, wiping the tears from his eyes as he ran over to me. 'How in hell do you like those oysters?'

" 'Not too hard to figure out,' I boasted. 'I've seen it happen before. Some nosey visitor with nervous fingers must have monkeyed with that valve setting.' And that's exactly what had happened.

"Next trip to Boston I learned that the furnace brickwork had been badly damaged. The smoke indicator had to be taken apart and given a good cleaning. Besides, everything in the plant had to be washed, painted or shined. That kept Spike's boys on their toes for months.

"And that was the last conducted tour through Spike's plant. Management came to the startling conclusion that while every human being is a potential shoe customer, he still doesn't have the right to play engineer at the shoe-company's expense.

"Spike did rope off a small corner of the engine room as a sort of visitors' gallery. People interested in wheels going around and around could stand there until they got dizzy. But they watched from a distance. Spike said he was hired for the important job of running the plant. He couldn't be responsible for a bunch of rubber-necking pranksters who yanked and turned things just to amuse themselves."—SME

Marmy's mailbox

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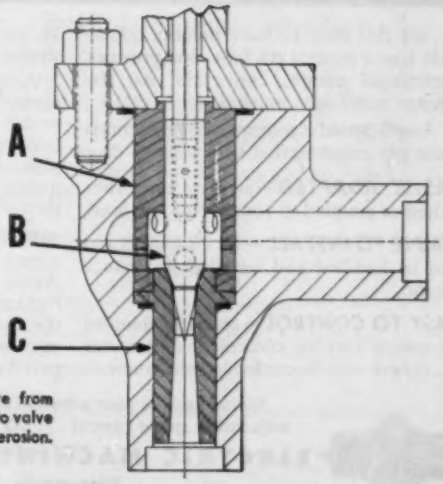
Quick-change Trim in the V-10 valve makes it possible for you to replace the valve seat, inner valve and guide in little more time than is required to dismantle and reassemble a bolted joint. No time is required for lapping the seating surfaces of the valve, since this is done in advance. *And you can make this quick trim change in minutes without removing valve from the line.* The savings to you are considerable in downtime and maintenance expense.

Republic V-10 Valves are available with either welded seat or replaceable seat, in addition to the Quick-change Trim design, with bolted or pressure seal bonnets. V-10 valve contours are designed to produce not only the desired regulating characteristics, but also to reduce erosion damage and noise as well. Precise manufacture and long-life materials make Republic regulating valves perform better, last longer, with less maintenance. For additional information, contact your nearest Republic Representative, or write to Republic Flow Meters Company, 2240 Diversey Parkway, Chicago 47, Illinois. In Canada: Republic Flow Meters Canada, Ltd., Toronto. Subsidiary of Rockwell Manufacturing Company.

Rockwell-Republic V-10 regulating valve with Type J-1 positioner is designed for rugged high-pressure liquid or steam service.



Quick-change Trim feature makes it possible to replace the seat guide (A), inner valve (B), and seat (C), without removing valve from the line. Seat extends to valve outlet to prevent body erosion.

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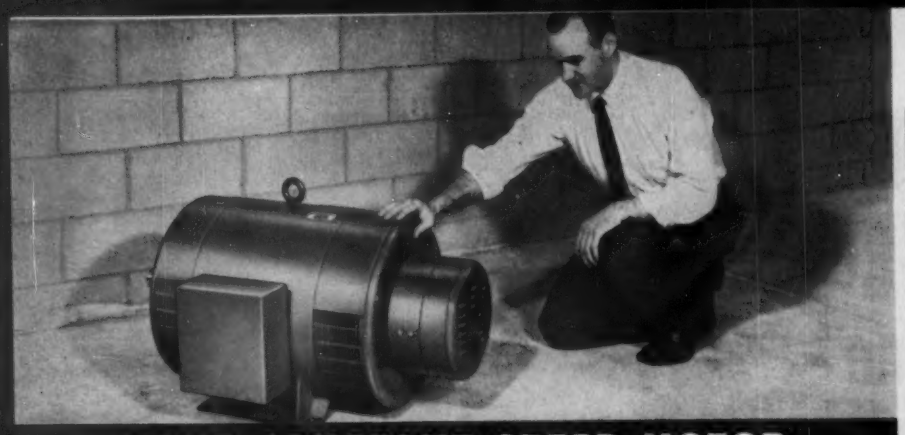

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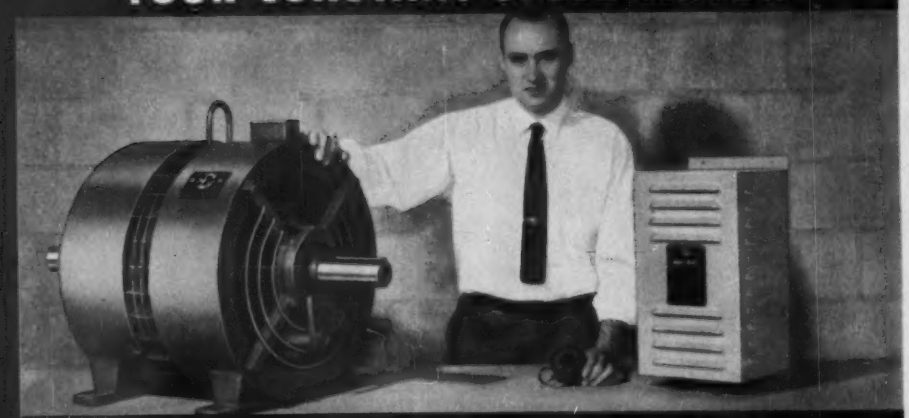

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Ampli-Speed is a simple, compact magnetic slip coupling that is:

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Somewhere in your plant an operation can be improved with adjustable speed control . . . DO IT YOURSELF WITH AMPLI-SPEED

ELECTRIC MACHINERY MFG. COMPANY
Minneapolis 13, Minnesota

Marmaduke

Begins on page 158

(*Marmy's lit piston, September '59* POWER) even for a few hours without exhausting the oxygen? Or is Marmy murdering science again?

L J JOHNS, *Philadelphia, Pa.*

EDITOR'S NOTE: *Here's Marmy's answer, near as we remember: "Truth is stranger than fiction because that duck lamp was lit. A triple-expansion marine engine is big. When the 62-in. low-pressure cylinder was opened, it naturally filled with oxygen. No doubt the oxygen leaked into all three cylinders, as well as the condenser and the steam line to the main stops. There was naturally leakage past the various piston rings and valves so that the slowly burning lamp was fed with enough oxygen to keep it burning until the cylinder head was again lifted. Then too, drains might have been left open on one or more cylinders and even on the condenser."*

EASY TO READ

Just read the book of Marmaduke stories and I find them most entertaining. I'm not an engineer, nor do I have a technical mind, but we seemed to be tuned in and I understand him. I'm an actress by profession and put on local and state pageants. Maybe that's why I like Marmaduke—I appreciate the ham in him.

HANNA BLOCK, *Wilmington, N.C.*

SECRETARY LIKES

The Marmy stories are not only great, but my secretary also looks for them. We here at GE's Nela Park keep up with him.

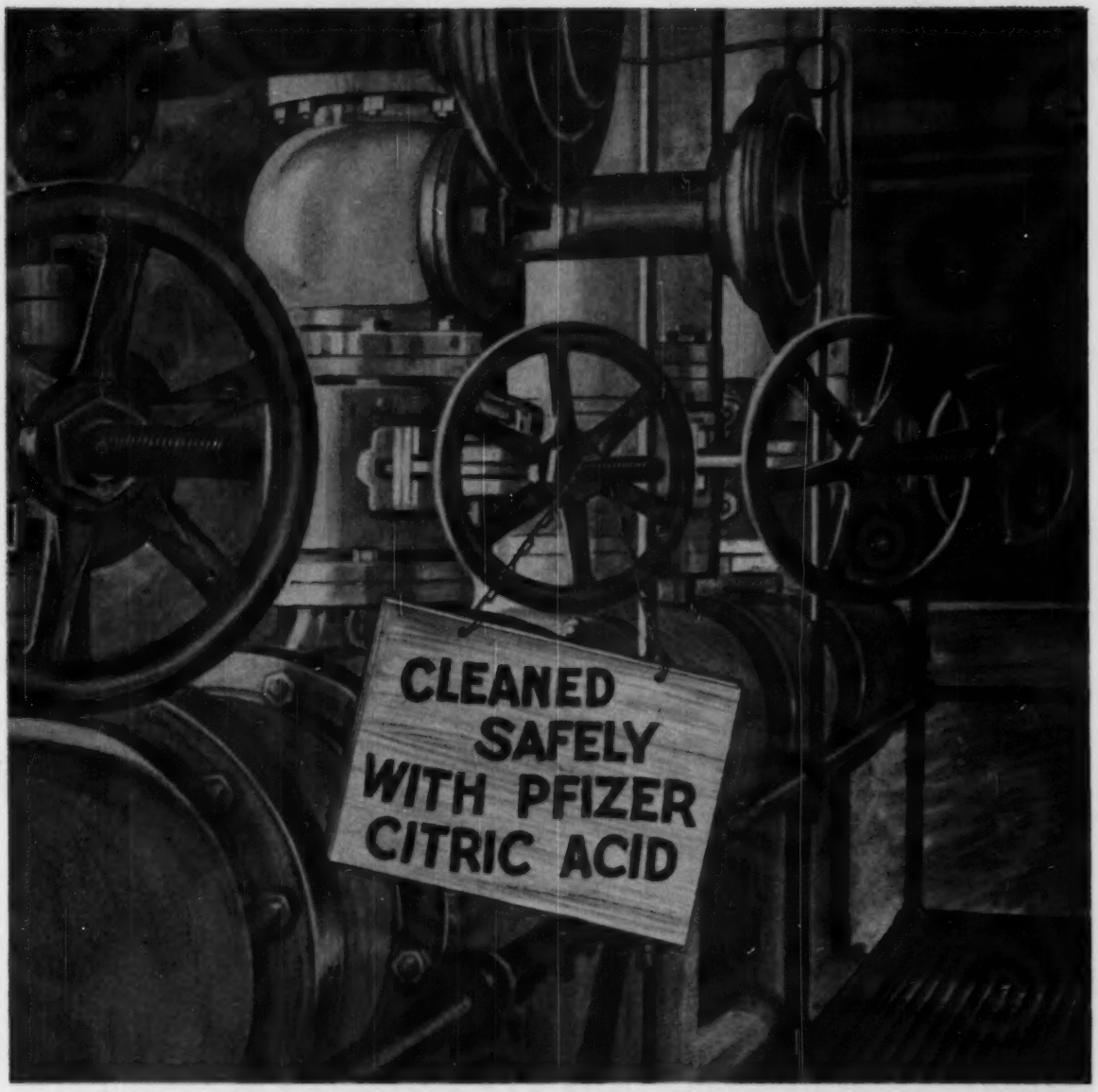
J L TUGMAN, *Cleveland, Ohio*

WHAT, MARMY GOOFED?

I believe Marmy goofed when setting up his dream pumping station on the Mississippi River. He should have installed a relief valve of ample relieving capacity between the discharge valve and the pump housing. That would have prevented the casualty due to unofficial tampering.

W A HAASE, *Clifton, N.J.*

◀ circle 300 on Reader Service card, p 109



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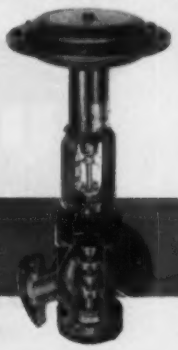
The controller unit utilizes conventional 3-15 psi signal air pressure, has a 0-150% adjustable proportional band, may be direct-, reverse- or snap-acting without parts change. The *Flexotrol* Level Controller can also be converted to a transmitter-controller combination. Automatic reset and rate response are optionally available.

Full details are given in Bulletin 456-1. A copy is yours for the asking.

*Flexotrol is a trade-name of Kieley & Mueller, Inc.



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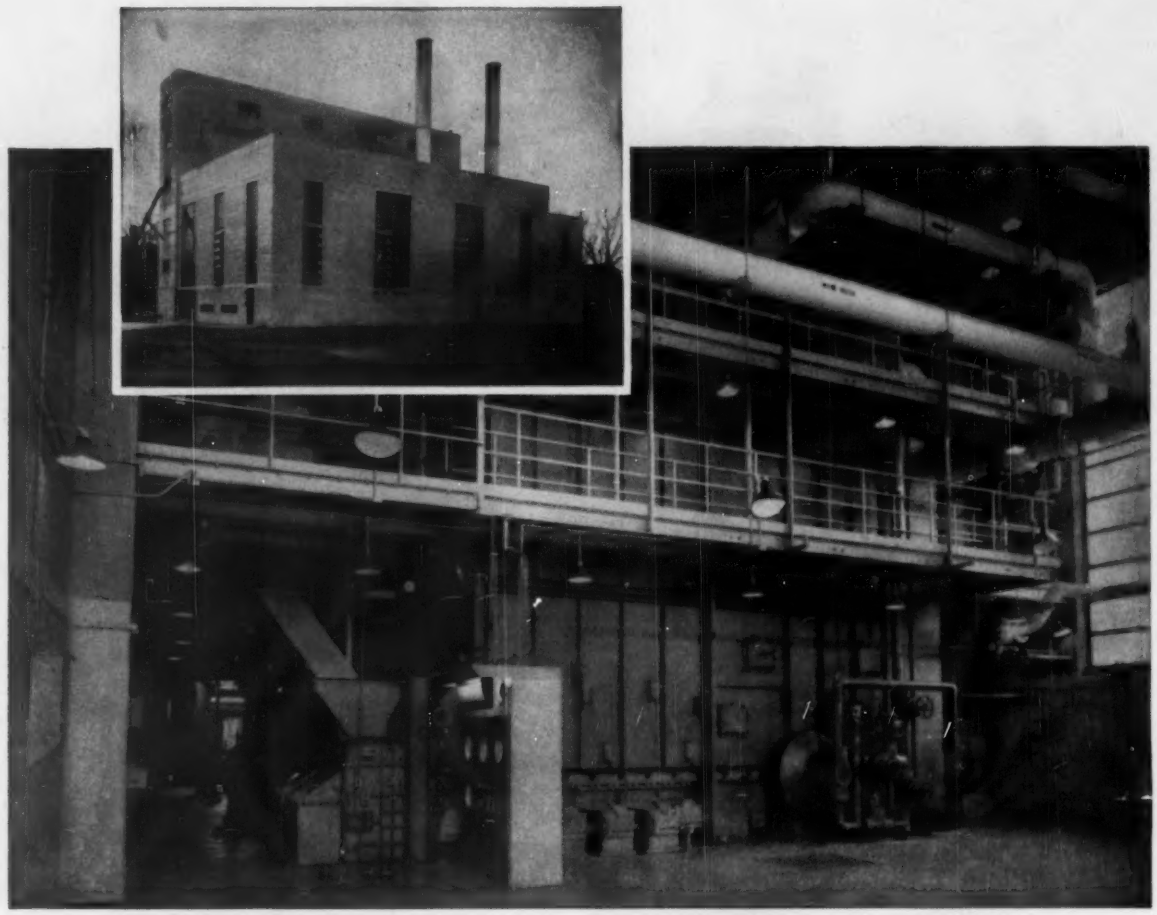

Union Boilers stretch fuel dollars at Mendota State Hospital

A dependable steam supply with low steam generating costs plays a key role in the efficient operation of the Mendota State Hospital. Occupying 384 acres near Madison, Wisconsin, it houses 900 patients and 491 employees in 40 buildings. To reach the furthest point of service, steam travels over half a mile from the power plant.

Carrying the load is a pair of Union 2-drum VO Type Steam Generators. Individually rated at 50,000 lbs./hr. at 165 psi, both units are fired with traveling grate stokers, and together, burn 12,000 tons of coal annually. Since the day this Union Boiler duo was installed, the hospital has enjoyed uninterrupted steam service.

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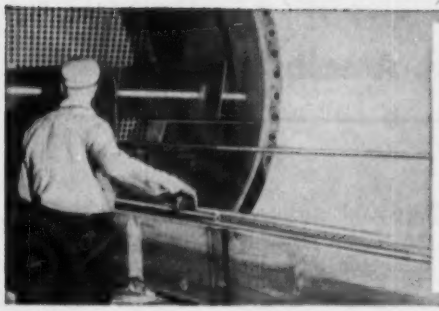

CONDENSER AND HEAT EXCHANGER CLINIC

Edited by A. W. Tracy, Metallurgical Engineer
The American Brass Company, Waterbury, Conn.

OPERATING FACTORS THAT AFFECT CONDENSER TUBE LIFE

Answers to some of the questions sent in following a previous clinic on this subject

Q. How effective is chlorination as a preventive maintenance procedure in cleaning tubes fouled by polluted water?

A. The chlorination of polluted sea water has been found to be effective in removing or preventing the formation of slimes on the walls of tubes. Better cleanliness was indicated by higher vacuum obtained on the steam side of the condenser. Tubes kept clean by chlorination have been reported to be less subject to pitting. It should be interjected here that tubes carrying polluted sea water containing sulfides from decomposition of organic matter seldom undergo inlet end corrosion, but the remainder of the length of the tubes often becomes pitted. Clean sea water, if entering the tube turbulently, will often cause corrosion at the inlet end, and usually the remainder of the length of the tube is coated with a good protective film of corrosion products.

The statement that chlorination may break down sulfide films on the walls of tubes is based on the fact that chlorine is an oxidizing agent and would oxidize sulfides; however, it is realized that the usual chlorine treatment would probably not remove thick long-standing sulfide scales.

Q. How often should tubes be cleaned and what are some of the methods used?

A. The required frequency of tube cleaning depends, of course, on how rapidly the tubes become fouled. In some power plants, tubes are cleaned once a week; at other stations, cleaning is required only at intervals of several months. Often the decision to clean tubes is determined by the drop in vacuum on the steam side.

In regard to methods for removing accumulations from condenser tubes, some station operators shoot rubber plugs through the tubes; others use bristle brushes, either of animal hair or nylon. The use of brushes is reported by some to do a better job of cleaning than the use of plugs.

An interesting method for continuously cleaning condenser tubes has been developed in Europe. A large number of sponge rubber balls, slightly larger in diameter than the inner diameter of the tubes and having about the same specific gravity as sea water, is fed continuously into the inlet water box. The cooling water forces the balls through the tubes, and deposits on the tube walls are swept away. The balls are collected by a cone in the outlet water box. They leave the water box through a tube connected to the end of the cone and are recirculated into the inlet water box. By the law of probability, each tube will eventually receive a ball. The system is not applicable to tubes that have been in service and have become rough and pitted.

Some stations periodically remove deposits from tubes by recirculating a dilute, inhibited hydrochloric acid solution through the condenser.

Q. How important are temperature and velocity as factors in the service life of condenser tubes?

A. Corrosion of condenser tubes is usually more rapid in summer than in the winter, but pollution due to bacterial action in the summer may be a more important factor than temperature itself. Instances have been observed where failures in a set of tubes occurred only in the warm-water months and none in the cold-water months, over a period of several years.

Mention was made in the clinic to the effect that high temperature of water causes pitting, due to the formation of gas bubbles on the tube wall. This type of pitting occurs most frequently, but not often, in oil refinery condensers where temperatures on the vapor side may be as high as 350F and water velocities relatively low. In a power plant condenser, temperatures on the vapor side ordinarily do not exceed 100F and temperature rise in the cooling water from the inlet to the outlet end is usually limited to 10F.

TECHNICAL ASSISTANCE. Our Metallurgical Department is regularly helping manufacturers, electric power companies, marine operators, petroleum and chemical companies to select the correct tube alloy for many types of condensers and heat exchangers. This service is available to you without obligation. Write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

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Powerscope . . . A selective look at

Computer control systems

In the two or three years ahead there will be widespread adoption of smaller computer control systems for one special purpose. They will have ability to do the job completely and cost only $30,000 to $40,000 compared to $300,000 for a general-purpose computer. In addition, processes will be laid out so they can be run by a computer. In three to five years analytical instruments and transducers will improve markedly. Analytical instruments will give improved reliability and uniformity without human intervention—digital transducers will give long-term stability. Instrument companies now have much more of a systems concept than they have shown in the past. Many process firms find that computer control improves product quality and enables their plants to reach rated output—so opines C E Jones, VP and General Manager of Daystrom, Inc, Control Systems Div.

The Daystrom electronic computer at the Sterlington plant of the Louisiana Power and Light Company ran 99.75% of the time for a 6-month period. System monitors 350 points and reduces information so it can be used as a guide by operators. System logs the data, prints out a permanent record and registers an alarm if any data deviates from preset standards. Oustanding reliability is attributed to: proven circuitry and components, eliminating moving parts by using magnetic-core memories instead of drums, eliminating stepping switches and conventional relays and using instead a relay with mercury climbing a capillary tube to make contact, replacing electronic tubes with transistors and diodes. Of the 0.25% unreliability, 0.06% was caused by malfunctioning of a power switch and 0.17% by a janitor banging a floor cleaner against the cabinet.

Ac power from heat

A high-temperature cesium-cell converter has produced enough ac electricity to light a series of small light bulbs at the John Jay Hopkins Lab of the General Atomic Div of General Dynamics Corporation. High-temperature nuclear reactors could be used to power the cesium cell. Electric power produced in the cell alternates in the range of 100 *kilocycles* compared to the standard 60 cycles; oddly enough, the cell produces both dc and ac at the same time. General Dynamics has special uranium fuel-converter element under design for the cesium cell. Uranium fuel in the center of the element heats the cesium-cell emitter that encases the fuel. The 3500-F surface of the fuel boils electrons into the cesium plasma. Current crosses the plasma to collect on the cold-surface element and act as the electric output of the cell.

New number names

National Bureau of Standards has adopted the recommendations of the International Committee on Weights and Measures for using new prefixes for numbers at high and low ends of the scale. Here they are:

Multiples and submultiples	*Prefixes*	*Symbol*
$1{,}000{,}000{,}000{,}000 = 10^{12}$	tera	T
$1{,}000{,}000{,}000 = 10^{9}$	giga	G
$1{,}000{,}000 = 10^{6}$	mega	M
$1000 = 10^{3}$	kilo	k
$100 = 10^{2}$	hecto	h
$10 = 10$	deka	dk
$0.1 = 10^{-1}$	deci	d
$0.01 = 10^{-2}$	centi	c
$0.001 = 10^{-3}$	milli	m
$0.000{,}001 = 10^{-6}$	micro	μ
$0.000{,}000{,}001 = 10^{-9}$	nano	n
$0.000{,}000{,}000{,}001 = 10^{-12}$	pico	p

Cryogenic techniques have made it possible to suspend a small metal body in a vacuum and turn it at high speed practically without friction, in the General Engineering Laboratory of General Electric Company. They expect that the body could spin freely for months or even years. This work has been carried out for the Army Ballistic Missile Agency in developing a cryogenic gyroscope. In cryogenic work the temperature is kept near absolute zero, about –460 F. In this range metals become superconductive and will conduct electric currents indefinitely. Superconductive materials act as magnetic insulators, repelling a magnetic field with enough force to suspend a body in space. Future possibilities for applying cryogenic principles are cited: shaping magnetic fields to make electron microscopes that could see atoms; superconductive coil with "frozen-in" circulating current as an accurate reference standard; frictionless bearings; motors with nearly 100% efficiency; amplifiers with no drift or noise; computers of extremely small size and low power needs; super conductors for transformers, generator windings, accelerator coils and energy-storage systems.

Rubber coating that has reduced drag by 50% on underwater measuring devices seems to offer a way to cut fluid friction for boats, ships, planes, missiles and rockets. Dr M O Kramer of Los Angeles, working with U.S. Rubber, calls the development "boundary-

layer stabilization by distributed damping." Coating is a thin layer of rubber supported by many tiny rubber pillars. Interconnecting channels between the pillars hold a freely flowing viscous liquid. Channels face the surface of the object. Water side of the coating is smooth. Channels give the coating flexibility and the liquid the damping to suppress potential turbulence. U.S. Rubber expects to produce the coating under the trade name Lamiflo.

New bidding method

Beginning this month, contractors submitting bids on boiler installation in New York State buildings must guarantee the boiler-plant efficiency. Bid prices will be determined by adding dollar value of predicted coal cost for ten years to dollar value of installation cost. Coal cost will be figured at current coal prices using the guaranteed gross efficiency. This gives an edge to high-efficiency boilers. Boilers will be tested according to ASME Power Test Code and contractors will be allowed to make adjustments as needed. Units that do not meet the guarantee will have liquidated damages withheld from contract payments. These will be figured as equal to the difference between actual cost of operation based on actual efficiency and the cost based on guaranteed efficiency for a period of ten years. Virginia is the only other state now using this method of evaluating bids.

Gas-turbine trial

The Federal Power Commission has authorized Columbia Gulf Transmission Co to build and run an experimental gas-turbine-compressor unit at its station near Clementsville, Ky. The 10,500-hp unit will be controlled remotely; it is a modified aircraft type jet engine. The experimental plant will cost about $1.55 million. Cooper-Bessemer Corp has agreed to furnish the unit without charge for a test of 8000 hr or 18 months, whichever comes first. C-B will pay $250,000 toward construction for a total of about $1,025,000. Columbia will pay the remainder to cover costs of materials and labor.

New test for metal cracking

Westinghouse research labs have developed a very fast method of predicting hot cracking in metal alloys. Test samples weighing less than an ounce accurately forecast susceptibility of multiton metals. Dr Hull's test assumes the tearing of a metal casting as it cools and shrinks from liquid to solid state is comparable to cracking of a weld as it freezes. Process uses levitation melting of a 20-gram sample in 10 to 15 sec in an argon atmosphere. Sample floats inside a high-frequency coil producing a magnetic field. Sample gets white hot, is stirred vigorously. After melting, metal pours into a copper mold, freezes into shape of a slightly tapered pin about 2-in. long and ¼-in. in dia. Ends of the pin lock in place to prevent normal contraction of the metal. Internal stresses built up tend to tear the metal apart. Comparing pins of different lengths and diameters builds up a scale to measure susceptibility to hot cracking. Scale evaluates characteristic for different alloys.

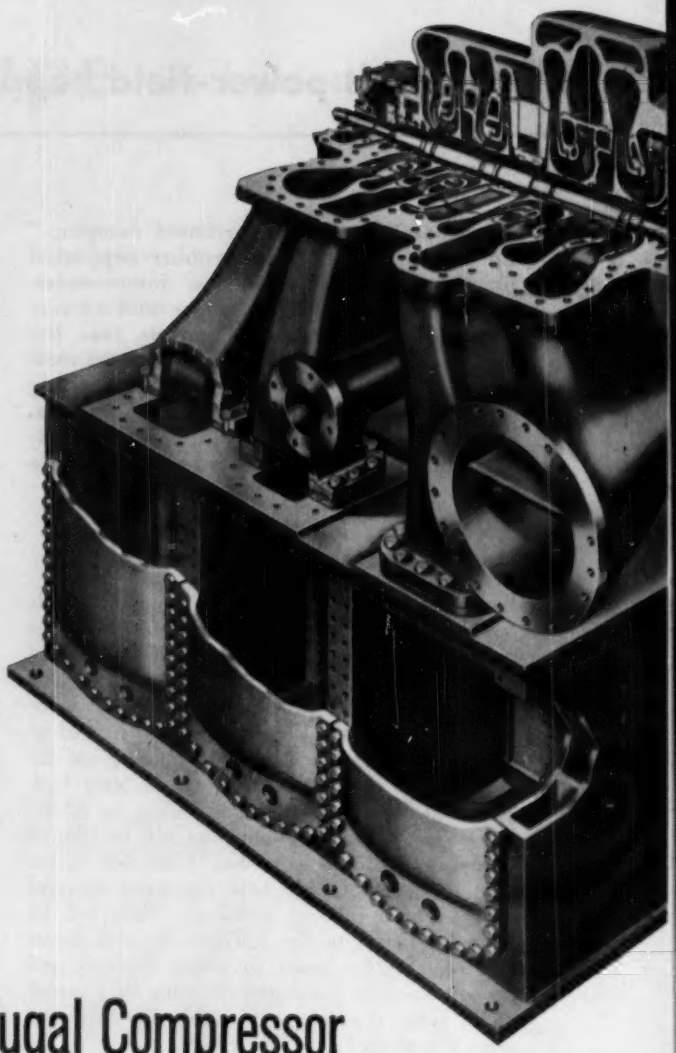
Giant motor drives

Propulsion wind tunnel with a transonic unit now running and a supersonic circuit nearing completion is the largest of 22 wind tunnels and test cells at the U.S. Air Force Arnold Engineering Development Center in Tullahoma, Tenn. World's largest rotating machine powers the wind tunnel. The 216,000-hp Westinghouse unit is over 480-ft long. It includes two most powerful synchronous motors each rated 83,000 hp, and two starting motors of 25,000 hp each. The four motors in tandem drive a 3-stage compressor for the transonic circuit and an 18-stage compressor for the supersonic circuit; both were built by Westinghouse.

Los Angeles Dept of Water and Power plans to build a $164 million dam and power plant at Bridge Canyon on the Colorado River. This unit, 173 miles upstream from Hoover Dam, would generate about half the power now used in L. A. Cost, including transmission lines and a silt-control dam, would be about $243 million. Main dam would be 466-ft high, compared to 726 for Hoover, and form a reservoir 52 miles long. Project would generate about 3-billion kwhr annually.

Engineering colleges now present a more integrated body of fundamental knowledge to students at the sacrifice of specialized knowledge characteristic of the past, says Dr G S Brown of MIT at the Winter General Meeting of the AIEE. Many graduates of the modern 4-year courses can enter any of several industries. But the power industry is less likely to find the ready-made specialists it may need. The needs of specialization may be met by postgraduate courses and training courses presented by industry.

For CHEMICAL PROCESSING and other INDUSTRIAL AIR applications ...this new CLARK Centrifugal Compressor



The new Clark Unatherm Centrifugal Air Compressor delivers high purity air at unusually high hydraulic efficiency. Operating in a pressure range from 85 to 125 psia, the new compressor is a single case, four-stage design.

To hold horsepower at a low level, the air stream is intercooled between each stage in base-mounted intercoolers. By mounting the compressors over the intercoolers, important savings in space requirements are realized. In addition to inherent compactness, the Clark design requires access to only one side for maintenance. The remaining three sides may be set flush against walls if required.

Another feature of the new Clark Unatherm Compressor is the use of back-to-back impellers to balance out thrust load. Integral bearing construction and single case design limit bearing and shaft sealing requirements to one at each end of the rotor and also eliminate alignment problems.

Being a simple rotative machine, normal maintenance consists of an occasional inspection. If ever necessary, however, the upper half of the case can be removed without disturbing bearings or breaking pipe connections.

The Clark Unatherm Compressor is an excellent choice for all industrial air uses requiring 110 psig air in capacities from 5,000 to 38,000 cfm. It is an ideal first stage compressor for oxygen plants, wind tunnels or soot blowing because of its unusual efficiency and air purity characteristics. The same advantages apply to base load, general industrial air applications where the complete absence of pulsation plus unusual compactness are also highly important features.

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Reports
from the field

Engineering education is like "swimming duck"

"True engineering education in the U.S. is similar to the duck swimming," the AIEE was told at its recent Winter General Meeting. "On the surface everything may look serene, but underneath educators are paddling industriously."

According to M L Manning of S. Dak. State College, electronics, rockets and research have brought new dimensions to engineering knowledge. Curricular reform is long overdue. The old distinctions between mechanical, electrical and civil engineering are fading, and just the basic principles of engineering analysis are complex enough to fill the engineering part of a 4-year program.

In the future, Manning thinks, detailed specialization may be deferred to graduate work, supplemented by industrial-sponsored on-the-job educational programs.

"Internships" and "residences" in engineering education are not far off, Prof W G Dow of the University of Michigan told a sectional meeting of the AIEE. New scientific knowledge is coming up fast; importance of graduate instruction increases by leaps and bounds. The university is hoping to extend its instruction to areas outside the campus. Because of the shortage of engineers, each man must be used professionally—and be capable of working—to the full extent of his abilities.

Why do engineering teachers go over to industry $ $ $

Money is the biggest reason why engineering teachers leave college for industrial positions, reports A R Hellwarth of the University of Michigan —but it isn't the only one. Other reasons include dissatisfaction with teaching loads, administrative details and relations with college and administration.

Extra work they did in college didn't faze the 235 former teachers surveyed. But they did want better income and more fringe benefits.

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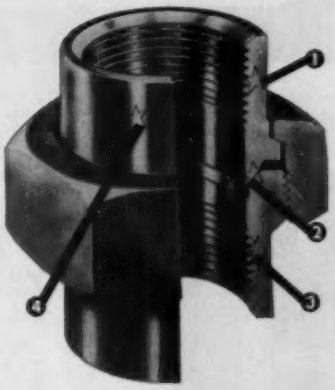

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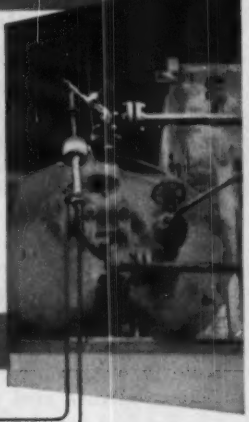

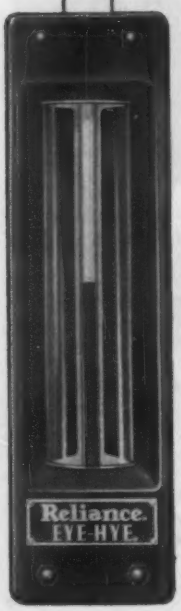

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The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio

Reliance BOILER SAFETY DEVICES

Reports from the field

Begins on page 176

Do these ex-teachers long to return to the satisfactions of academic life? Most of them said they would forsake teaching for industry again if they had the choice, but 195 hoped eventually to return to the campus after gaining practical experience. Or, as one man said wistfully, "when I can afford to return."

Computer progresses, gets a college education

General Motors engineers have decided to educate their computers to fit them for higher jobs. Data-processing men reporting to the Society of Automotive Engineers discussed DYANA, the dynamics analyzer-programmer which helps an IBM 704 computer answer vibrational problems faster than ever before to solve car-building problems.

Digital computers always work at blinding speeds, of course. But in the past an engineering problem had to be worked out in terms of precise mathematical formulas, then coded into detailed instructions the computer could understand. Now DYANA teaches the computer a simple language. The engineer himself can describe his problem to the computer and tell what type of answer he wants, instead of going through a battery of specialized middlemen.

First computer-control system in the chemical-processing industry was announced by the B F Goodrich Chemical Company. Unit is now in operation at their Calvert City, Ky. plant. RW-300, engineered and manufactured by Thompson-Ramo-Wooldridge Products Co, is used to improve efficiency of producing vinyl chloride monomer. Unit accepts instrument signals, computes at great speed, makes logical decisions and transmits signals to adjust set-points of numerous controllers. So far, shakedown-period results have exceeded expectations.

In another application, the computer is "riding the rails" to help railroads operate 2-way traffic on single-track rights of way, General Railway

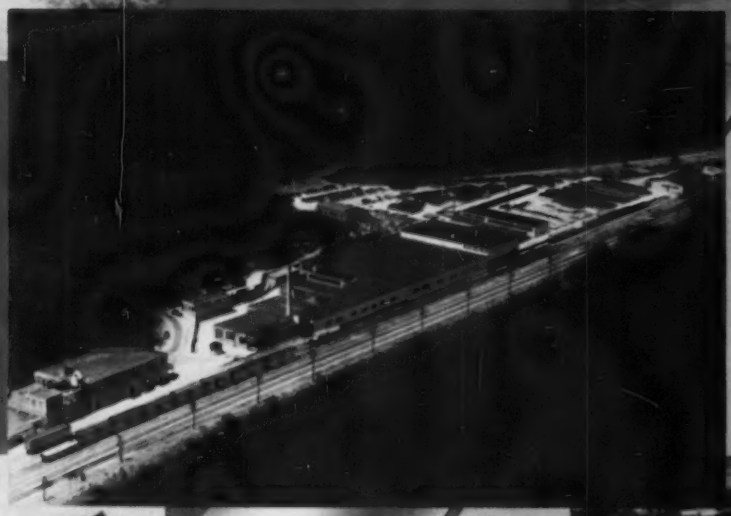
For more facts circle 309 on Reader Service card, p 109

circle 310 on Reader Service card p 109 ➤

1910 . . . Original Ric-wil one room building

1928 . . . Two story plant located on Brown Street in Barberton, Ohio

1960 . . . Present plant site in Barberton covers 10½ acres with 11 buildings.



1956 . . . Establishment of Ric-wil Company of Canada, Ltd. St. Thomas, Ontario

1959 . . . Establishment of Western Ric-wil Company, Newark, California

RIC-WIL...

50 Years of Growth

Fifty years of continued growth and expansion is a tribute to the RIC-WIL helically corrugated prefabricated insulated piping systems.* Systems that are engineered in correct basic design and quality built. Each unit, accessory and fitting is entirely prefabricated in factories equipped for this exclusive work. All conduit is pre-tested before delivery to the job site . . . in short . . . a system that offers the greatest strength and thermal efficiency obtainable for distribution piping.

Complete literature is available on the many types of systems . . . it's yours for the asking.

Covered by U. S. Patents 2330966, RE. 22988, 2378214. Other patents pending.

Quality Piping Systems . . .
. . . of Exceptionally High Thermal Efficiency

RIC-WIL PREFABRICATED INSULATED PIPING SYSTEMS

CENTRAL OFFICE: RIC-WIL INCORPORATED, BARBERTON, OHIO
WESTERN STATES: WESTERN RIC-WIL COMPANY, NEWARK, CALIF.
IN CANADA: THE RIC-WIL COMPANY OF CANADA LIMITED

Public Service Electric and Gas Co. Turns Fly Ash Problems Into Profit

By using Fuller pneumatic conveying systems, the Sewaren Generating Station of Public Service Electric and Gas Company, New Jersey, was able to collect 4100 tons of fly ash during 1957. Not only did this eliminate a serious disposal problem that formerly contributed heavily to operating costs . . . it also gave the utility which sold the collected fly ash, a new and valuable source of income.

The Fuller-Kinyon system at Sewaren collects and carries the fly ash to two storage silos that have a combined capacity of 380 tons. It is then either bagged in 50-lb. lots or transferred in bulk through a Fuller loading-out silo spout to tank trucks or covered dump trucks. Labor and equipment costs are kept at a minimum. Dusting is avoided, and high tonnages are handled easily over considerable distances. Extra handling flexibility is provided by a Fuller two-way diverting valve that permits unsuitable fly ash to be pumped directly to an ash reject tank instead of to storage.

Fuller pneumatic conveying systems can be installed almost anywhere at minimum costs, regardless of plant conditions. Moisture and dirt cannot enter the system and material cannot escape. Write today for detailed information in Bulletin FF-49-1. 1334 G-202

Fuller
pioneers in harnessing AIR

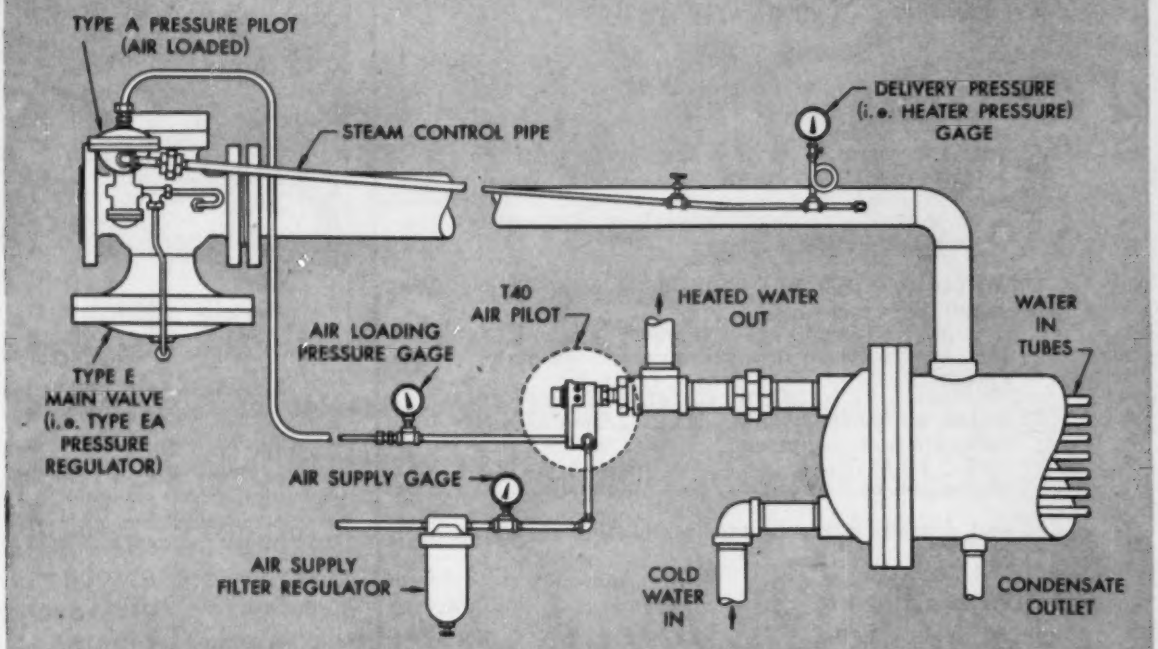
FULLER COMPANY
126 Bridge St., Catasauqua, Pa.
Subsidiary of General American Transportation Corporation
Offices in Principal Cities throughout the world.

For more facts circle 311 on Reader Service card, p 109

(Advertisement)

VALVE TIPS:

New Spence Temperature Control System Gives Unusual Control Accuracy


TYPE A PRESSURE PILOT (AIR LOADED)
STEAM CONTROL PIPE
DELIVERY PRESSURE (i.e. HEATER PRESSURE) GAGE
T40 AIR PILOT
HEATED WATER OUT
WATER IN TUBES
AIR LOADING PRESSURE GAGE
TYPE E MAIN VALVE (i.e. TYPE EA PRESSURE REGULATOR)
AIR SUPPLY GAGE
AIR SUPPLY FILTER REGULATOR
COLD WATER IN
CONDENSATE OUTLET

TYPE EAT40 AIR-CONTROL TEMPERATURE REGULATOR

In a recent installation the new Spence air-control temperature regulating system provided:

- ±5°F control accuracy under wide and instantaneous load swings of 210 to 80 gallons per minute.
- Up to 50% reduction in cost as compared to instrument systems of similar accuracy.

This unique cascade-type control with throttling range adjustment independent of maximum heater pressure was developed to meet today's demand for greater control accuracy.

Additional features of the new Spence Temperature Control System include:

- 200°F wide adjustable temperature range
- Adjustable speed of steam pressure change
- Over and under temperature protection
- Pressure limit control
- Fast response
- Very low air consumption
- Field reversible for heating or cooling

The Spence Type EAT Air Control Temperature System, when properly installed, will tame wide ranging, fast changing loads of instantaneous heaters and modern heat exchangers. The cascade principle plus the use of an extremely fast responding bi-metal temperature sensing element reduce time lags and provide control stability.

Here's how the new Spence system operates:

Quick response is based on a bi-metal temperature sensing element.

Temperature pilot continuously regulates a loading air pressure.

This loading signal, when applied to a pressure regulator to reflect heater temperatures, causes it to adjust the main valve as changes in load require.

Spence has also developed a new pressure control system based on this same cascade principle. This system has a control accuracy of ½ psi or better from positive pressures through the vacuum range to 30" Hg.

For complete information on these new air controlled temperature and pressure control systems, write for your copy of Bulletin 9.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

For more facts circle 312 on Reader Service card, p 109

FILL IN AND MAIL TO
WESTERN CHEMICAL COMPANY
Kansas City 5, Mo.
Pioneers in the chemical control of problems relating to the use of water, steam and fuel

"I have a problem..."

- ☐ scale, corrosion, or foaming in my boiler operation
- ☐ rust and corrosion in my steam and condensate return lines
- ☐ scale, corrosion, or algae growth in my cooling or condenser water system
- ☐ corrosion or scale in my potable or plant water supply lines and tanks
- ☐ rust and corrosion in my brine or sweet water system
- ☐ scaled up pumps, water jackets, compressors, coils, lines, or equipment
- ☐ sludge and moisture in my fuel oil supply
- ☐ soot deposits in my furnace combustion areas

"I'd like to know..."

. . . exactly what specific treatment your Technical Services Dept. recommends. I understand that such problems have been your specialty for over 65 years and that you have an outstanding record for restoring and maintaining efficiency of plant equipment through advanced chemical treatment. Will look forward to receiving in the near future both your latest technical literature *and* a personal letter concerning my problem. I understand that my inquiry involves no obligation.

NAME_____ TITLE_____

FIRM_____

ADDRESS_____

CITY_____

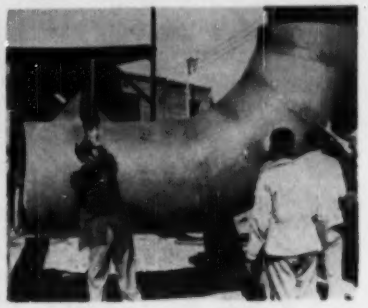
ZONE_____ STATE_____

Mail to Technical Services Dept., WESTERN CHEMICAL CO.
713 Washington St., Kansas City 5, Mo.

Reports from the field

Begins on page 176

Signal Co engineers told a meeting of the AIEE. Computer program helps management select proper siding locations and signal spacing. IBM 650 handles traffic pattern of ten trains operating at one time on a 100- to 150-mile railroad division.



Polyester elbow added to ventilation system

Huge elbow, 48 in. in dia and weighing almost 500 lb, is a component of the ventilating system installed at a Midwest metallurgical plant. Unit was fabricated from fire-resistant reinforced polyester resin, molded by du Verre, Inc out of Hetron polyester resin.

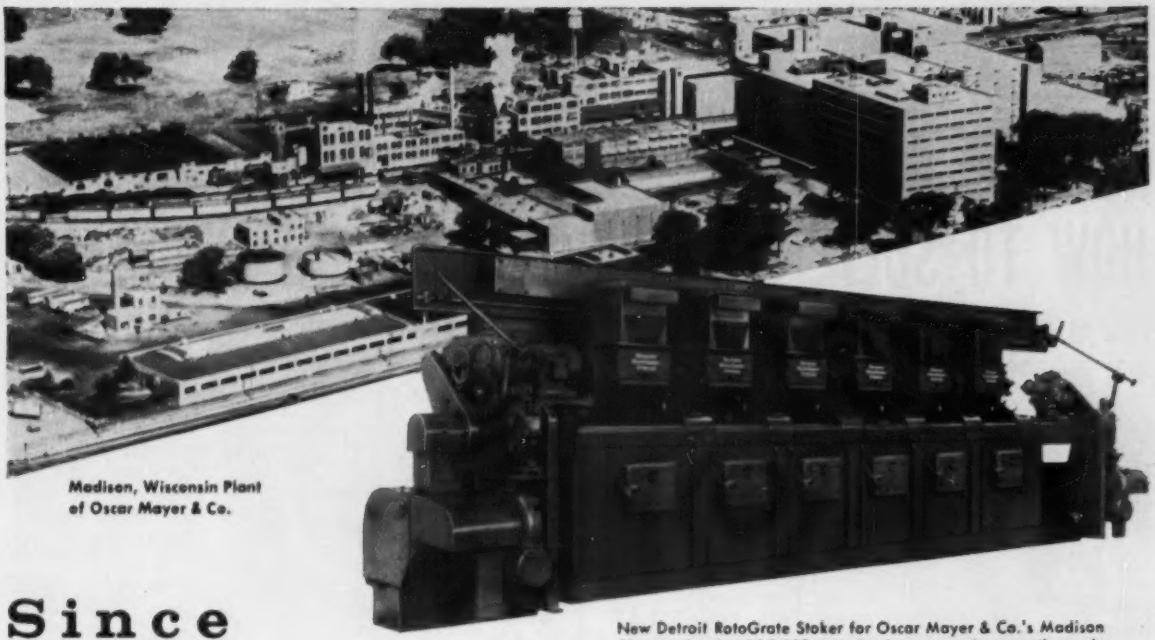
Four new precipitators will keep Baltimore clean

Battery of electrostatic precipitators will guard against air pollution at the Baltimore Gas and Electric Co's new Charles P Crane Station, now under construction on the shores of Chesapeake Bay.

Units are currently being erected at the station site. They were built in the Baltimore shops of the Koppers Company.

Each of the four units for initial installation will be about 25-ft wide, 18-ft deep and 27-ft high. Each is designed to handle 152,000 cfm of dust-laden gas from a coal-fired cyclone boiler rated at 1,360,000 lb steam per hr. With coal firing, 80 to 85% of the total ash is removed as slag. Precipitators will remove 95% of remaining flyash.

continued



Madison, Wisconsin Plant of Oscar Mayer & Co.

New Detroit RotoGrate Stoker for Oscar Mayer & Co.'s Madison Plant to develop 125,000 pounds of steam per hour continuously for 24 hours—150,000 pounds for peaks, when burning Indiana coal, 10530 BTU per pound, 13.25% ash, A. F. T. 1900° F. Helmick and Lutz, Minneapolis, Consulting Engineers.

Since 1938

Detroit Stokers have served Famous Sausage Makers with Economy . . . High Availability . . . Low Maintenance

Oscar Mayer & Co., pioneer meat processing firm, has been making sausages since 1883. By stressing quality and uniformity of product, it has grown from a small meat market on the near-north side of Chicago to the nation's 9th largest producer with sales last year of $260,000,000.

In 1938, the company installed a Detroit RotoStoker in the Madison, Wisconsin, plant. Purchase of a plant in Davenport, Iowa, brought them another RotoStoker in 1941.

These served so well that in 1947, they bought a Detroit RotoGrate Stoker for the Madison plant as a part of an expansion program.

When more expansion was planned in 1959, they bought two more RotoGrates, one each for the Madison and Davenport plants, making a total of five acquired since 1938.

Detroit RotoGrate is an overthrow spreader stoker with traveling grates that move slowly forward, discharging ash at the front. Suitable for boilers up to 400,000 pounds of steam per hour capacity . . . it burns any bituminous coal or lignite and many types of refuse, separately or in combination with coal. It is one of the complete line of Detroit Stokers for small, medium and large boilers.

DETROIT STOKERS COST LESS

DETROIT SINCE 1898 STOKERS

Cost equals initial investment plus upkeep, plus production losses due to equipment outage. *The total is less with Detroit.*

DETROIT STOKER COMPANY

MAIN OFFICE AND WORKS • MONROE, MICHIGAN

District Offices or Representatives in Principal Cities

For more facts circle 314 on Reader Service card, p 109

SARCO TOPICS

HOW TO SOLVE COMMON TRACER LINE PROBLEMS

How to cure water hammer with a steam trap that will operate in vertical position

Water hammer is an inherent problem in long tracer lines. So is freezing. Both problems can be overcome, and here's an example of how it has been done. At the Socony Mobil Oil Company's Paulsboro, N. J., refinery, they found that the Sarco Thermo-Dynamic Steam Trap, type TD-50, not only withstands water hammer, but installing the trap in a vertical position —which permits free drainage—presents no problems at all, thanks to its unique thermodynamic principle. In fact, 90% of the 250 TD-50's at this plant are vertically mounted. They never block heat transfer, and they remove condensate and air as fast as they collect.

How to handle varied steam pressures — without adjustment

Can a trap — without adjustment — handle steam pressures that vary from 15 to 160 psi? Can the *same* trap vent air and drain condensate as rapidly as it is formed, be easy to install and require practically no maintenance at all? That was the problem set up by the engineering staff of Armour Chemical Division's McCook plant. They solved it by testing many traps. Their conclusion: Sarco TD-50 steam traps meet or beat their specifications, because:
they discharged condensate as fast as it formed, without wasting steam;
their compact inline construction made installation easy, even in tight quarters;
maintenance was practically negligible;
no adjustment was necessary for varying steam pressures. (In fact, the TD-50 is self-adjusting through its full operating range of 10-600 psi.)

No other steam trap can so adequately solve all these problems at one time.

How to be certain process fluid stays above 280° F. when outside temperature drops to —10° F.

The problem of maintaining design temperatures on tracer lines need not be difficult, no matter how extreme the conditions seem to be. For example, the tracer lines in a phthalic anhydride process at Witco Chemical Company's new Chicago plant had to be maintained above 280° F. Below this temperature, the chemical sets and the whole system would have to be taken apart and re-assembled. That's not all; ambient temperatures sometimes could drop to −10° F.

With reliability as a prime consideration, Scientific Design Company, Inc., who designed and constructed this brand new plant, selected the TD-50.

Because the TD-50 can be mounted vertically, freezing was no problem either. Added benefits that matter on tracer lines: the TD-50 is compact, light in weight, easy to install.

What is the most reliable tracer line trapping method to prevent unscheduled shutdown?

Particularly in refineries, steam traps have to function under exactly the kind of conditions that you'd expect to cause failure—they must function equally satisfactorily on low pressure or exhaust steam and on up through high-pressure, high temperature ranges. Not only that, but outside temperature may vary from subzero to subtropical. If maintaining design temperatures in your tracer lines appears to be hampered by these problems, consider how Phillips Petroleum Company, Kansas City, solved them. They found a trap which drains their tracer lines automatically over a full range of pressure, temperatures and loads. It's the Sarco TD-50 Steam Trap.

With only one moving part—a stainless steel disc, the TD-50 has little that can go wrong. In fact, it's so free of trouble that Phillips Petroleum Company consider their TD-50's as reliable and efficient as the piping. They now rely on 1800 of them throughout the plant.

1408

FOR FULL INFORMATION ON TRACER LINE TRAPPING or on any steam trapping problem—see your Sarco Sales Representative or write to

SARCO COMPANY, INC.
635 Madison Avenue,
New York 22, N. Y.
Plant: Bethlehem, Pa.

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES

SARCO

Here are 7 Sound Reasons Why the Thermo-Dynamic® Does a Better Job of Trapping

1. *Simplicity*—has only one moving part. 2. *Maintenance*—practically zero. 3. *Wide pressure range*—one trap for all pressures from 10 to 600 psi. 4. *Uniform performance*—operates equally well on heavy, light, or no condensate load. 5. *Operates against back pressures*—up to 50% of inlet pressure. 6. *Rugged*—unaffected by superheat, water hammer, vibration, or corrosive condensate. 7. *Minimizes inventory* of spare parts.

Maintenance Time: 40 Seconds. If it now takes your maintenance crew more than a couple of minutes to service an ordinary trap, you're throwing away valuable time. This Sarco Thermo-Dynamic can be cleaned, blown out if necessary, and reassembled on the line in as little as 40 seconds.

For Prompt Information on the TD-50 . . . or for fast help on the efficient solution of any steam trapping problems, get in touch with a SARCO District Office, Sales Representative, or Distributor. (There's one near you.)

Only SARCO makes all 5 types:

Thermo-Dynamic* • Thermostatic • Liquid Expansion • Float Thermostatic • Inverted Bucket

*U.S. Pat. No. 2,817,353 TM Reg. U.S. Pat. Off. 1409

SARCO COMPANY, INC.
635 Madison Ave., New York 22, N. Y.

circle 316 on Reader Service card, p 109

Reports from the field

Begins on page 176

"Hot cell" starts work in Santa Susana Mts

A privately owned facility for remote examination of radioactive materials is in operation in the Santa Susana Mountains near Los Angeles. According to Atomics International, this is the largest privately owned facility of this type in the world.

Known as the Components Development Hot Cell, it is used for development of experimental atomic-reactor fuel elements and for testing various irradiated reactor materials and components.

The 17,799-sq-ft building has four large, shielded compartments arranged in rectangular blocks and interconnected by transfer drawers. Inert atmosphere of less than 1% oxygen can be maintained in each cell.

Facility has nine operating stations with shielded windows and mechanical "arms" for handling radioactive materials in the cells. Remotely controlled by operators, these manipulators are capable of threading a needle or lifting up to 750 lb. "Hot Cell" is located at Atomics International's 290-acre nuclear field lab.

Wanted: Engineer-technician for modern maintenance

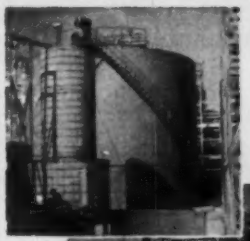
Increasing automation in American factories calls for a new kind of maintenance man, says a General Electric Co executive. A highly trained engineer-technician is needed to cope with complex electronic control systems.

Smooth production flow is more important than ever in an automated factory because of capital tied up in equipment, losses that follow when a continuous process is halted by breakdown of one component.

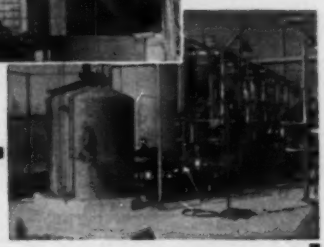
"In many plants today, the maintenance man is the most highly skilled workman in the shop, the last of the craftsmen," said J J Durkin, head of GE's Service Shops Dept. Perhaps all the trouble-shooter does is take away a "black box" and put in a new one—but to do this he must understand design of the whole control

WHO CHOSE H&T?

For Boiler Feedwater Conditioning Equipment



400,000 lb. per hour fully automatic demineralizer plant with silica and CO_2 removal



These Fine Companies Did!

A Partial List of Installations

Duquesne Light Co.
Shippingport, Pa.

Yankee Atomic Electric Plant
Rowe, Mass.

Ohio-Edison Co.
Akron, Ohio

Bowaters-Carolina Corp.
Catawba, S.C.

Knolls Atomic Power Laboratory
West Milton, N. Y.

The Cleveland Elec. Illuminating Co.
Ashtabula, Ohio

Chevrolet Div. Gen. Motors Corp.
Tarrytown, N. Y.

R. J. Reynolds Tobacco Co.
Stokes County, N. C.

Tampa Electric Co.
Tampa, Florida

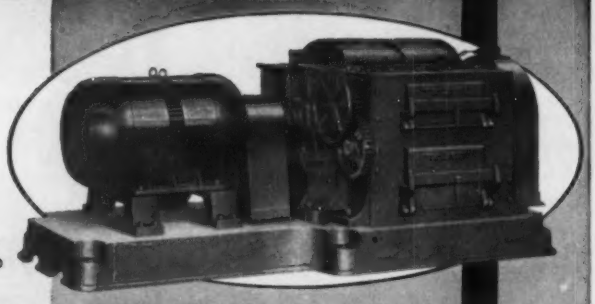
U. S. Gypsum Co.
Chicago, Ill.

Send for new Bulletin 50 Years of Progress

HUNGERFORD & TERRY, Inc.
CLAYTON 3 NEW JERSEY
H&T SERVICE

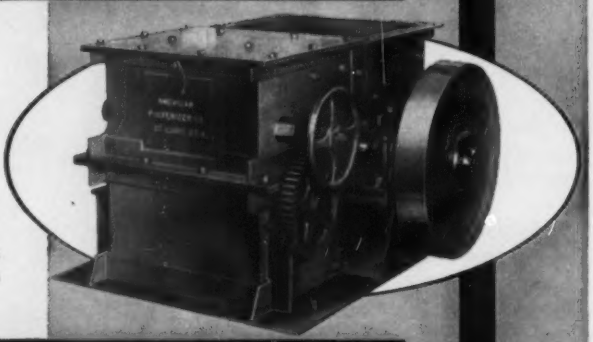
circle 317 on Reader Service card, p 109

When You Figure . . .



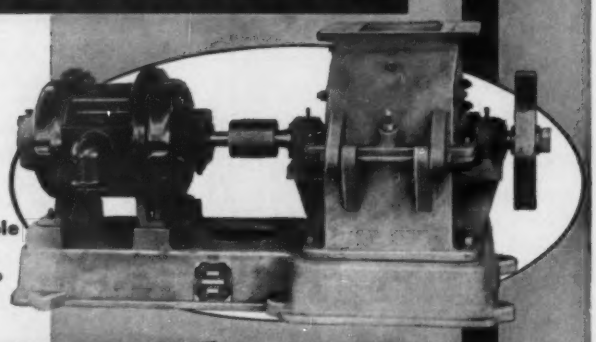
AC Series
capacities to
800 TPH

Reduction
Cost Per Ton . . .



WC Series
capacities to
90 TPH

the Best Answers*. . .



Coal Sample
Crushers
capacities to
2000 Lbs.
Per Hr.

Come from American
Ring Coal Crushers

*In a recent independent survey, it was found that American Crushers reduced over 61,000,000 tons of coal at a parts replacement cost (including standby parts) of *less than 1/10th of 1¢ per ton.*

THERE CAN BE NO BETTER PROOF OF AMERICAN QUALITY!

American
PULVERIZER COMPANY

WRITE for Literature on These Crushers

Originators and Manufacturers of Ring Crushers and Pulverizers

1349 MACKLIND AVE. • ST. LOUIS 10, MO.

Reports from the field

Begins on page 176

system. In the future, predicts Durkin, maintenance of automatic and computer-controlled equipment may be supplied by 'pooled' technicians in key locations throughout the country.

SNAP-3 celebrates a happy birthday

Pint-sized atomic generator unveiled last January by the AEC is still producing electricity after a year of continuous operation. Unit was originally intended to demonstrate maintenance-free operation for only 140 days.

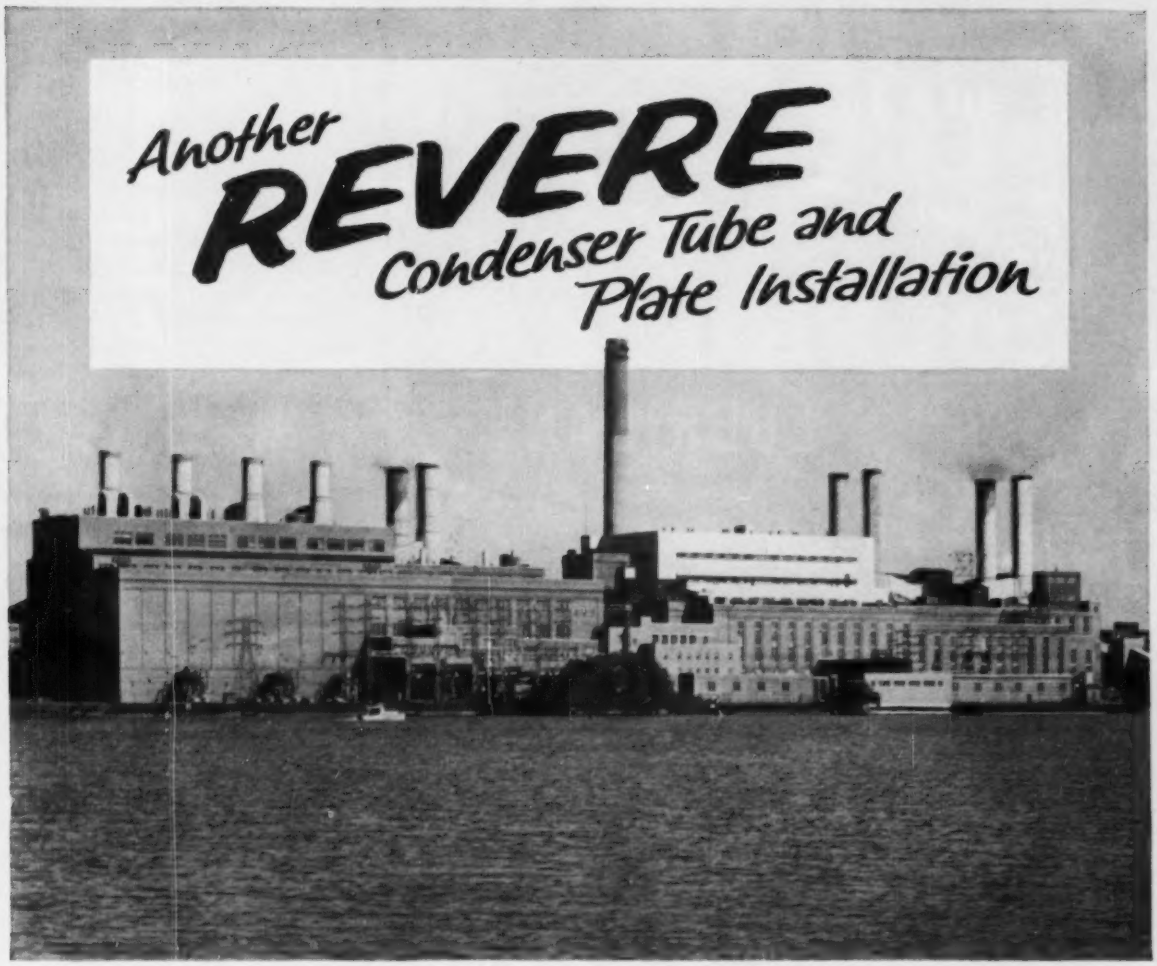
Nuclear Div of The Martin Co, who designed and built SNAP, say the System of Nuclear Auxiliary Power has tested successfully in a vacuum, and at temperatures down to –100 F. They've produced eight of the midget generators, but only two have been loaded with radioisotope fuel; others were equipped with electrical heating devices for testing.

Steam-Power Symposium series started for U.S. utilities

Worthington Corp kicked off the first of its Steam-Power Symposium series at Public Service Electric & Gas Company, Newark, N. J. on Jan 22. Planned as a continuing program, the symposiums in 1960 will visit 15 leading utilities across the country.

Symposiums will cover the latest

For more facts circle 318 on Reader Service card, p 109



Another Dependable Worthington Condenser for

NIAGARA MOHAWK POWER CORPORATION

(Unit #67 Huntley Steam Station, Buffalo, N. Y.)

The 95,000 sq. ft. Worthington Surface Condenser is equipped with 196,000 pounds of Revere Admiralty Condenser Tubes, and 29,000 pounds of 1½" thick Revere Muntz Metal tube sheets.

These particular metals were selected by the manufacturer because they best fit the specific operating conditions that will be encountered in this particular installation. Other operating conditions and requirements call for other alloys.

It is this careful selection of the "metal to fit the job" that has built, for Revere, a reputation for dependable condenser tube and plate performance under all kinds of operating conditions.

Over the years Revere's Research Department has compiled extensive data regarding the relative corrosion resistance of the different alloys under a wide variety of operating conditions. Why not take advantage of this storehouse of facts and consult with Revere's Technical Advisory Service before selecting the tubes and plates for your equipment?

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801
230 Park Avenue, New York 17, N. Y.

Mills: Rome, N.Y.; Baltimore, Md.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Brooklyn, N.Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities. Distributors Everywhere.

INTEGRAL FINNED TUBE • BIMETAL TUBE • INSTRUMENTATION TUBE • CONDENSER TUBES OF CUPRO-NICKEL, ALUMINUM BRASS, ADMIRALTY, HERCULOY, ARSENICAL COPPER, MUNTZ METAL AND OTHER ALLOYS. ALUMINUM TUBE, SHEET AND EXTRUSIONS. SMALL AND LARGE PLATES IN CUPRO-NICKEL, COPPER, HERCULOY, MUNTZ METAL, NAVAL BRASS AND ADMIRALTY

For more facts circle 319 on Reader Service card, p 109

Free! Sample Tube of MOLYKOTE® G LUBRICANT

Industry's NEWEST Production TOOL

- ALMOST 100% SAFETY AGAINST GALLING AND SEIZING WITH ALL BEARING METAL COMBINATIONS
- ELIMINATES STICK-SLIP, METAL PICK-UP AND DISTORTION IN PRESS FITTING
- REDUCES WEAR-IN TIME AND DAMAGE IN NEW OR REBUILT MACHINERY
- THE HIGHER THE LOADS, THE GREATER THE MARGIN OF SUPERIORITY OF MOLYKOTE G

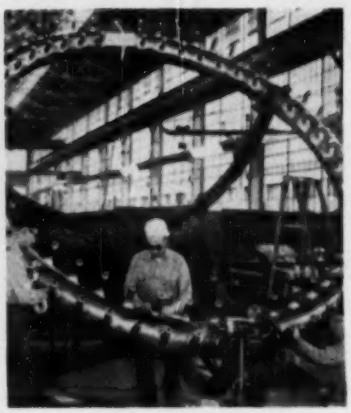
Write for your free sample of MOLYKOTE G LUBRICANT today. We will also send you a copy of our new Bulletin 126 which gives complete details. THE ALPHA-MOLYKOTE CORPORATION, 65 Harvard Avenue, Stamford, Conn. Phone Fireside 8-3724. Plants in Stamford, Conn., Munich, Germany and Strasbourg, France.

THE ALPHA-MOLYKOTE CORP.
65 Harvard Ave., Stamford, Conn.
Please send me a free sample of your MOLYKOTE G Lubricant.

NAME_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE____ STATE_____

MOLYKOTE G LUBRICANT

background on steam-power plant fluid-handling equipment, explain new applications and establish effective communication between the company and utilities. Major trends in the utility field to be highlighted: (1) higher operating pressures and temperatures (2) larger turbine-generators (3) superpressure steam plants and (4) nuclear fuels.



Nuclear outlet header nears completion

Outlet header for the Hanford Plutonium Recycle Test Reactor, being built by General Electric for the AEC, is being fabricated by Dravo Corp. Piping is in three segments welded to form a 13-ft 6-in. dia ring. Photo, above, shows specially forged bull tee and some of the ninety 1½-in. outlets for connections to water cooling lines.

Powerhouse employees set new world record

Ford Motor Co's Power and Utilities Services employees in the Rouge area have set a new world safety mark, the company reports. After working 2,199,564 man-hours without a disabling injury, from Feb 1, 1957 through July 10, 1958, they established a new record for steam, heat and power facilities in the private utilities industry.

continued on page 188

For more facts circle 320 on Reader Service card, p 109

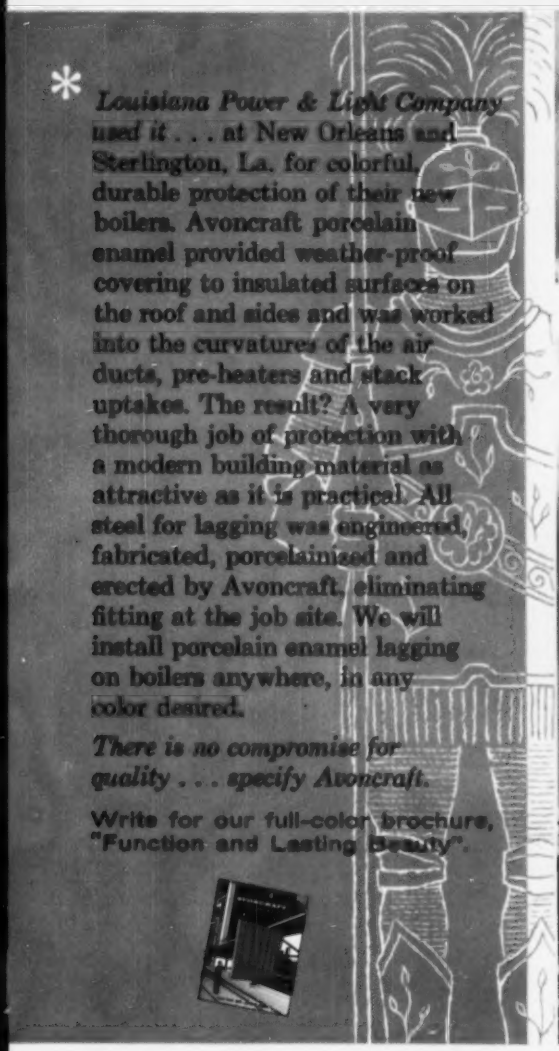
circle 321 on Reader Service card, p 109 ▶

a modern suit of armor . . . *

for power installations

AVONCRAFT

ARCHITECTURAL PORCELAIN ENAMEL



* *Louisiana Power & Light Company used it* . . . at New Orleans and Sterlington, La. for colorful, durable protection of their new boilers. Avoncraft porcelain enamel provided weather-proof covering to insulated surfaces on the roof and sides and was worked into the curvatures of the air ducts, pre-heaters and stack uptakes. The result? A very thorough job of protection with a modern building material as attractive as it is practical. All steel for lagging was engineered, fabricated, porcelainized and erected by Avoncraft, eliminating fitting at the job site. We will install porcelain enamel lagging on boilers anywhere, in any color desired.

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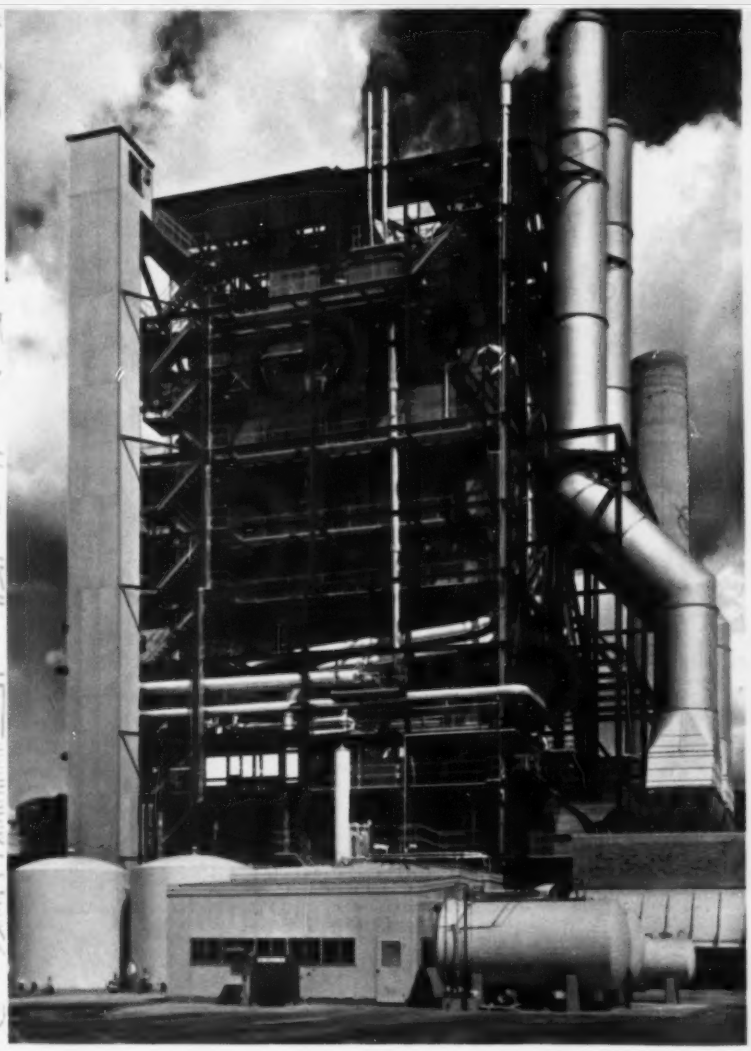

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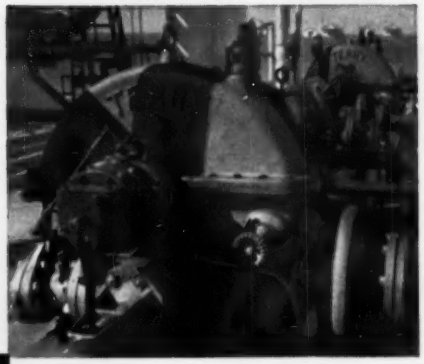
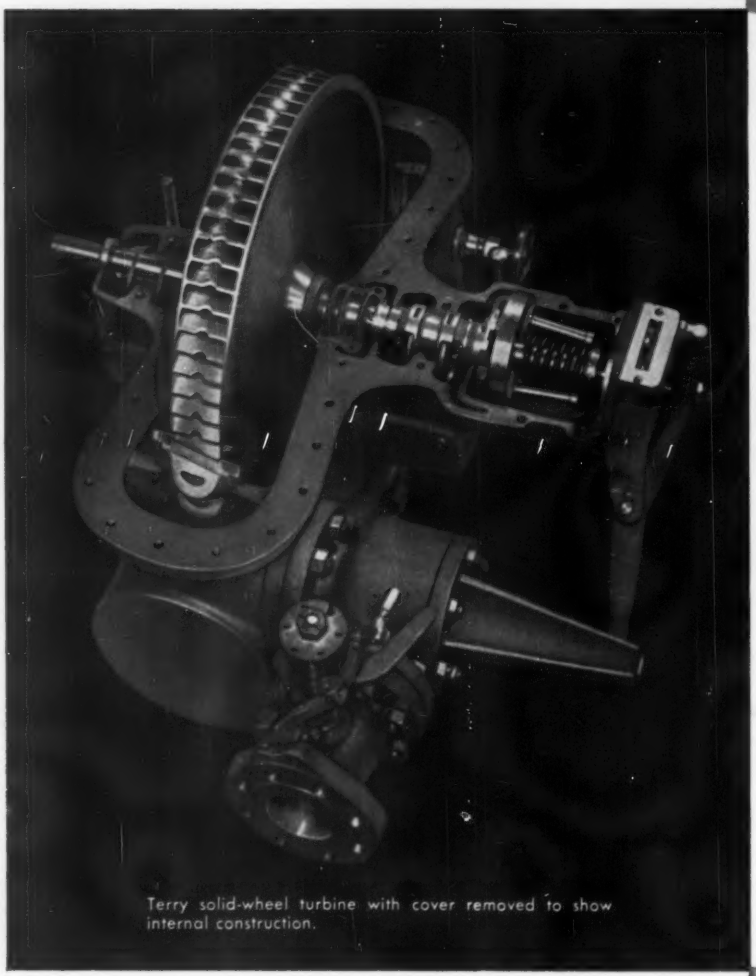
TERRY SOLID-WHEEL TURBINE

spells service continuity for mechanical drives





Terry solid-wheel turbine with cover removed to show internal construction.

For mechanical-drive applications, such as these, you will never find the equal of Terry solid-wheel turbines for built-in dependability. They are *designed* for trouble-free operation under the toughest service requirements.

The wheel, for example, is a single forging of special composition steel. Unlike a built-up wheel, there are no separate parts to loosen or work out. The blades can't foul since they are double-rim protected... with one-inch clearances at either side.

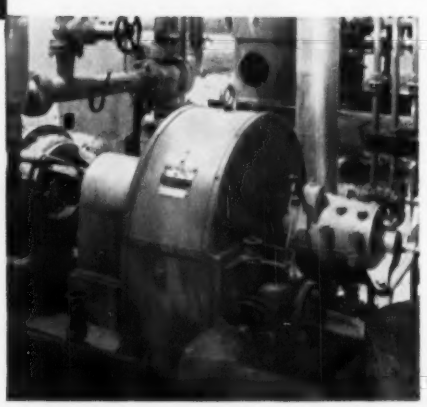
Any blade wear, which might occur after years of service, is of little consequence. As the power-producing action of the steam takes place on the curved surfaces at the backs of the buckets, wear does not materially affect horsepower or efficiency.

Specify Terry solid-wheel turbines for your next mechanical drives. They are available in capacities from 5 to 2,000 hp., speeds up to 10,000 rpm. Vertical turbines are built in sizes from 5 to 300 hp.

For full information about these reliable turbines, send for bulletin S-116.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



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For more facts circle 323 on Reader Service card, p 109

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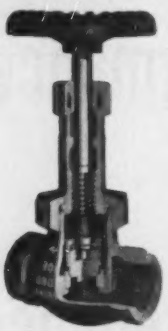
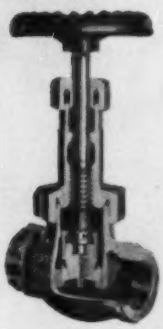


Full-Port 200 Brinell Nickel Alloy Radial Disc and Seat.
Fig. 0541—Globe, Fig. 0543—Angle, Sizes ¼ thru 2 inches. Made to give full flow on high pressure, high temperature steam, water, gas, oil and air lines.

Full-Port 500 Brinell Stainless Steel Plug Disc and Seat.
Fig. 0545—Globe, Fig. 0547—Angle. Sizes ¼ thru 2 inches. Designed for full flow when fully opened and for severe service of throttling and frequent operation.



Throttle-Port 500 Brinell Stainless Steel Cone-Plug Disc and Seat.
Fig. 0551—Globe, Fig. 0553—Angle. Sizes ¼ thru 3 inches. Recommended for most severe service and where constant throttling is required.

Service: 300# Steamworking pressure at 550° F.; 600# Cold Water, Oil or Gas Pressure—Non Shock.

Fairbanks features: Two-Piece Radial Seat Union Bonnet, a true ball and socket connection assures a tight seal time and again and facilitates the removal of the bonnet assembly for the regrinding or placement of the disc and seat. Bottom-seated Seat Ring has tight seal on pressure side. Valves may be repacked under pressure when wide open. Protected Top Seat, above stem threads and out of stream flow, makes a tight seal when valve is full open. All parts of three valves may be interchanged size for size and type for type.

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Reports from the field

Begins on page 176

Metalclad fused load interrupters OK for h-v work

The 1959 National Electrical Code, now available from the National Board of Fire Underwriters (New York, Chicago and San Francisco), has been substantially rewritten and expanded. Among revisions is recognition of metalclad fused load interrupters for switching and protecting high-voltage power circuits (not over 25 kv).

Paragraph 230-106. (a) (2) reads, "where voltage is 25,000 or less, a non-automatic oil switch, an air load-interrupter switch or other approved switches capable of interrupting the rated circuit load, and suitable fuses, may be used."

U of Wis. offers meeting on hydro and electric plants

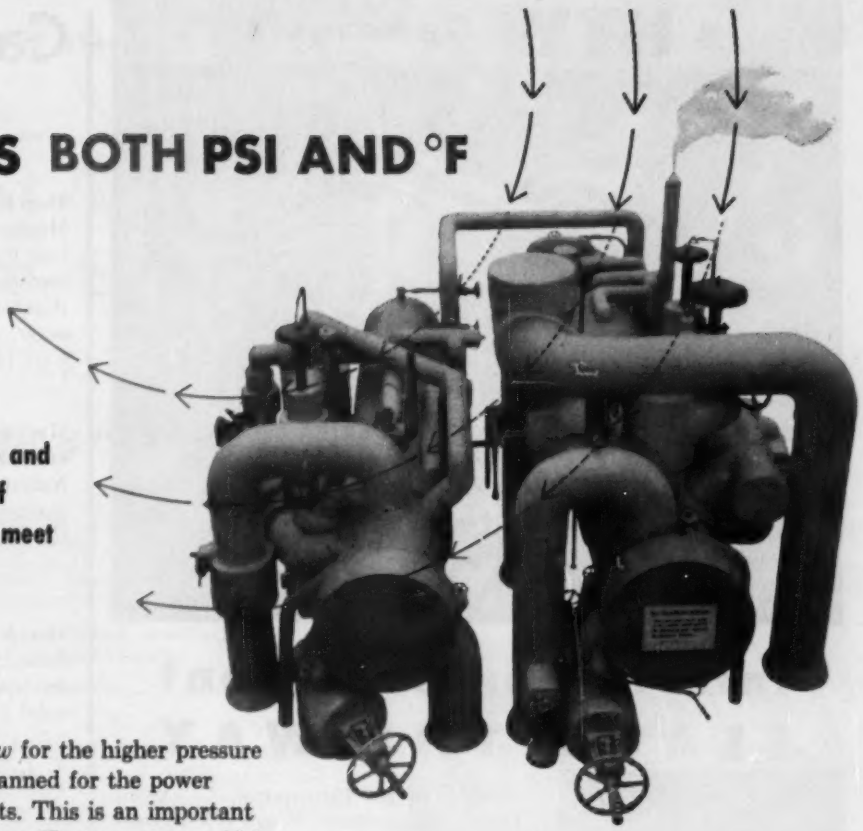
A 4-day meeting on hydro-plant and electric-plant operation will be conducted by the University of Wisconsin's Dept of Engineering of the University Extension Div. Meeting is offered with the cooperation of Colleges of Civil Engineering, Electrical Engineering. It will be held on March 21 to 24.

The last of three meetings covering the same subject matter, course is planned for utility-plant operating and supervisory personnel, representatives of manufacturers of related equipment, consulting engineering firms and electrical contractors' personnel. Each day will be devoted to a specific topic: hydrology and hydraulics, fundamentals of electricity, electrical machinery and utility systems in general.

Course material will be closely related to a 25-unit training course for hydroelectric-plant operating personnel developed by U.S. Dept of Interior, according to P J Grogan, chairman of the meetings.

Fellowship program to attract recent engineering graduates to teaching will combine teaching, research, advanced study at Newark College.

YUBA LICKS BOTH PSI AND °F



Exclusive Multilok Closure and all-welded construction of Yuba Feedwater Heaters meet requirements of newer generating stations

Yuba has the products *now* for the higher pressure and temperature ranges planned for the power industry's new steam plants. This is an important reason why Yuba Feedwater Heaters are so widely specified throughout the industry today. Operating in the 4,000 PSI, 1,000 °F range now, Yuba Feedwater Heaters, incorporating the exclusive *Multilok Closure*, are suited for all future pressure and temperature developments.

Advanced engineering keeps Yuba ahead . . . the new *all-welded construction*, for example. Shells are welded to channels without flanges, eliminating possible leakage that can occur in other construction at high pressures and temperatures. For low and intermediate pressures, Yuba's bolted design is applicable.

When space is important, Yuba can combine several heaters—effectively designing two or more stages in a single shell. For all your needs, Yuba specialists will discuss with you in detail, the design, construction and advantages of Yuba's *years ahead* Feedwater Heaters.

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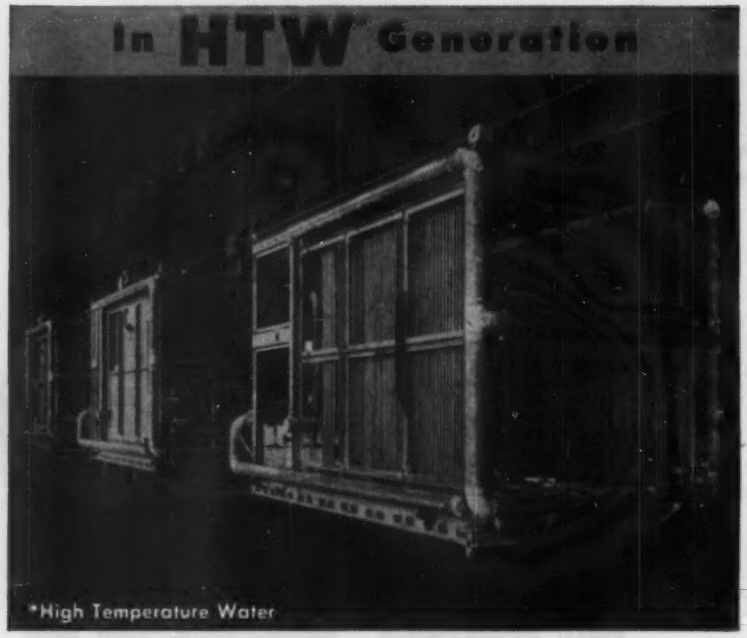

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Calendar

of events

March 6-9—American Society of Mechanical Engineers, Gas Turbine Power and Hydraulic Divisions, conference and exhibit, Rice Hotel, Houston, Texas. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

March 21-23—National Electrical Manufacturers Association, National Electric House Heating Exposition, Sherman Hotel, Chicago, Illinois. Details: R Gingles, NEMA, 155 E 44th St, New York 17, N. Y.

March 29-30 — Conference on Solving Liquid and Gaseous Industrial Wastes Problems, sponsored by Mid-Atlantic States Section Air-Pollution Control Association, N. J. Sewage and Industrial Wastes Association, Hotel Traymore, Atlantic City, New Jersey. Details: R M Manganelli, Rutgers University, Nicol Ave, New Brunswick, New Jersey.

March 29-31—American Power Conference, Sherman Hotel, Chicago, Illinois. Details: J A Miller, Illinois Institute of Technology, 35 W 33rd St, Chicago 16, Illinois.

April 3-8—American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc, 6th Nuclear Engineering & Science Congress, Coliseum, New York City. Details: AIME, 29 W 39th St, New York 18, N. Y.

April 3-8 — Instrument Society of America, 6th Nuclear Conference, New York City. Details: ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

April 4-7—Oil Heat Institute of America, Inc, 23rd National Oil Heat and Air Conditioning Exposition, Coliseum, N. Y. Details: C Pesterfield, OHI, 500 Fifth Ave, New York 36, N. Y.

continued

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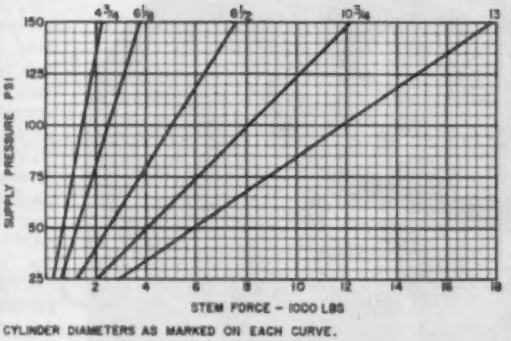
Type 470 mounted on Design "A" body

PERFORMANCE DATA

Air Consumption (Static)	20 SCFH at 100 psi supply.
Instrument Signals	3 to 15 psi, 5 to 25 psi, 6 to 30 psi, 12 to 60 psi. Suitable for split range also.
Temperature Limitation	175°F.
Maximum Hysteresis	.15% of total stroke or instrument signal.
Repeatability	.03% of the total stroke or instrument signal.
Resolution Sensitivity	Minimum change in the measured variable to produce an effective movement of the final control element is .02% of the instrument pressure range.
Frequency Response	1.4 cps for the Size 60. 4 cps for the Size 30.
Load Sensitivity	Percent of total travel per 100 lbs. stem force is .065% for Size 60.



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Calendar

Begins on page 190

April 5-7—Instrument Society of America, 3rd National Chemical and Petroleum Instrumentation Symposium, Rochester, N. Y. Details: ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

April 6-7—Lead Industries Association, 32nd Annual Meeting, Chase-Park Plaza Hotels, St. Louis, Missouri. Details: D M Borcina, LIA, 60 E 42nd St, New York 17, N. Y.

April 6-7—Oil Heat Institute of America, Inc, 38th Annual Convention, Coliseum, N. Y. Details: OHI, 500 Fifth Ave, New York 36, N. Y.

April 7-8—American Society of Mechanical Engineers, Management Engineering Conference, Statler Hilton Hotel, New York City. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

April 18-19—Joint Conference on Automatic Techniques, sponsored by ASME, AIEE, IRE, Sheraton Hotel, Cleveland, Ohio. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

April 19-21—American Society of Lubrication Engineers, 15th Annual Meeting and Lubrication Exhibit, Netherland Hilton Hotel, Cincinnati, Ohio. Details: C L Willey, 84 E Randolph St, Chicago 1, Ill.

April 21-22—American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc, Pacific Southwest Regional Metals & Minerals Conference, Ambassador Hotel, Los Angeles, Calif. Details: AIME, 29 W 39th St, N. Y. 18, N. Y.

April 21-22—Illuminating Engineering Society, South Central and Southeastern Regional Conference,

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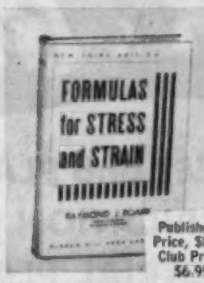

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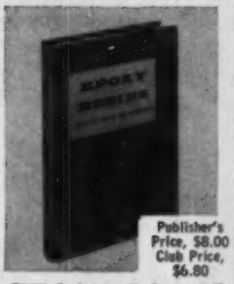

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P-3

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Calendar

Begins on page 190

Peabody Hotel, Memphis, Tenn. Details: J F Fletcher, Standard Electric Co, 876 Vance Ave, Memphis, Tenn.

April 25-26—Illuminating Engineering Society, Southwestern Regional Conference, Robert Driscoll Hotel, Corpus Christi, Texas. Details: B L Guess Jr, 1210 York Ave, Corpus Christi, Texas.

April 25-26—American Society of Mechanical Engineers, Maintenance and Plant Engineering Conference, Chase-Park Plaza Hotel, St Louis, Missouri. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

April 25-29—American Society of Mechanical Engineers, Metals Engineering Division—AWS Conference, Biltmore Hotel, Los Angeles, Calif. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

April 27-30—Western Air Conditioning, Heating, Ventilating and Refrigeration Exhibit and Conference, sponsored by Western Air Conditioning Industries Association, Shrine Exposition Hall, Los Angeles, Calif. Details: F J Tabery, 3443 South Hill St, Los Angeles 7, Calif.

April 28-29 — Illuminating Engineering Society, Inter-Mountain Regional Conference, Mountain Shadows Hotel, Scotsdale, Arizona. Details: D L Ruff, Arizona Public Service Co, P.O. Box 2591, Phoenix, Arizona.

April 28-30—American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc, Pacific Northwest Regional Conference, Sheraton Hotel, Portland, Oregon. Details: AIME, 29 W 39th St, New York 18, N. Y.

May 2-3—American Institute of Mining, Metallurgical, and Pe-

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MODEL 1050 MULTI-PORT
For boiler pressures up to 1050 psig.
Vision length—5 port—12⅜" and 7 port—18". Longer vision lengths easily obtained by adding 18" or 12⅜" sections for necessary length.

SMALL ROUND PORTS INSTEAD OF LONG GLASS AND MICA STRIPS
GAUGE NEVER REMOVED FROM BOILER FOR GASKET CHANGES OR OTHER NORMAL MAINTENANCE
STEAM SHOWS RED
WATER SHOWS GREEN
COMPLETE PORT CHANGE REQUIRES ONLY ABOUT 15 MINUTES
EACH PORT THERMALLY INDEPENDENT

MODEL MP-3000 MULTI-PORT
For boiler pressures up to 3000 psig.

Note These Features:

- **Less Maintenance — Greater Availability — Ports seldom need changing.**
- **Thermal Stability — Warm-up in minutes instead of hours.**
- **Ports are 1⅛" diameter on MP 1050 Gauge.**
- **Gauge body machined from a solid block of stainless steel. Welded tube and flange connections.**
- **"Hi-Lite" Illuminator — More visibility with less cleaning.**

The individual glass disks provide inherent thermal stability not obtained in the continuous vision gauge which requires the long glass and mica. Thermal stress is much less troublesome and damaging. Small mica disks cost less, and are not subject to wrinkling or cracking. Any port — glass, gasket and mica — may be replaced in minutes without removing the gauge from the boiler. Torquing operations are much less critical, and warm-up period is minutes instead of hours.

The Bi-Color feature makes reading sure. By an invariable optical principle, steam always shows red, water green. Changes in level show instantly. 8302

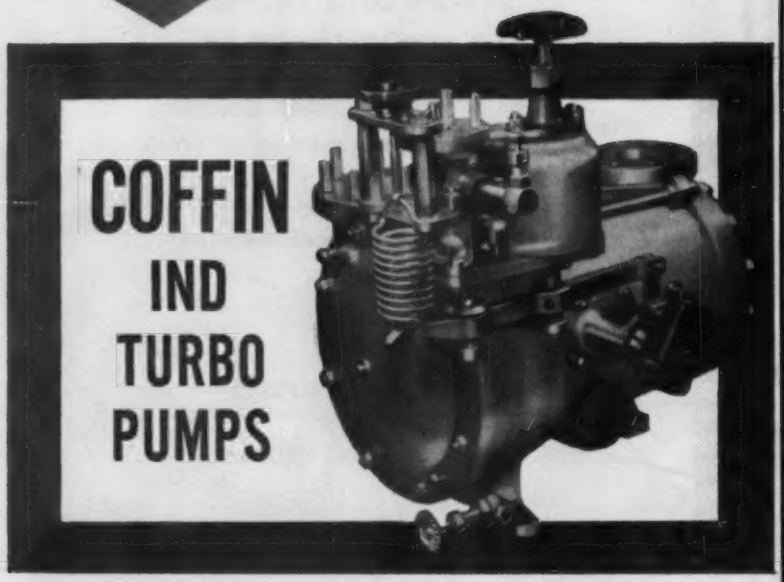
For a trouble-free gauge that makes reading of water level sure and easy — Diamond Multi-Port Bi-Color —

Write for
Bulletin 2044-A for pressures up to 1050 psig
Bulletin 1174 for pressures up to 3000 psig

DIAMOND POWER SPECIALTY CORPORATION
LANCASTER, OHIO • DIAMOND SPECIALTY LIMITED • Windsor, Ontario

For more facts circle 331 on Reader Service card, p 109

Complete Pump, Turbine and Controls



PACKAGED — integral design of the IND Pump results in a compact, highly efficient unit which mounts impeller and turbine wheel on a short, rigid shaft. The unit is equipped with complete controls for constant or differential pressure regulation.

APPLICATIONS — compact and highly efficient, the Coffin type IND Steam Turbo Pump is designed for General Boiler Feed or any other pumping service where medium volume and high pressure is required.

SPECIFICATIONS-

Capacities	to 180 GPM —	Height 32"
Discharge Pressures	to 350 PSIG —	Width 25"
Liquid Temperatures	to 300°F —	Length 32"

For special installations these ratings may be exceeded.

Coffin Turbo Pump Co.
326 South Dean Street, Englewood, N. J.
Gentlemen: Please send me illustrated booklet further describing the Type "IND" Pump.

Name _____
Position _____
Company _____
Street _____
City _____ Zone _____ State _____

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COFFIN TURBO PUMP
Hydrodynamics Division
FOOD MACHINERY AND CHEMICAL CORPORATION
326 South Dean Street • Englewood, New Jersey
Agents in all Principal Cities • Cable Address: COFCO

Calendar

Begins on page 190

troleum Engineers, Inc, 4th Biennial North Texas Secondary Recovery Symposium, Wichita Falls, Texas. Details: AIME, 29 W 39th St, New York 18, N. Y.

May 2-3—Instrument Society of America, Electrical Safety Instrumentation Symposium, Wilmington, Delaware. Details: ISA, 313 Sixth Ave, Pittsburgh, Pa.

May 4-6—Illuminating Engineering Society, South Pacific Regional Conference, Ambassador Hotel, Los Angeles, Calif. Details: W Shalda, Shalda Mfg Company, P.O. Box 507, Burbank, California.

May 5-6—American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc, Rocky Mt Petr. Sections, Annual Joint Meeting, Calgary, Alberta, Canada. Details: AIME, 29 W 39th St, New York 18, N.Y.

May 9-10—Illuminating Engineering Society, Pacific Northwest Regional Conference, Benjamin Franklin Hotel, Seattle, Wash. Details: G D King, Sylvania Electric Products, Inc, 3466 E Marginal Way, Seattle, Wash.

May 9-11—Instrument Society of America, 3rd National Power Instrumentation Symposium, San Francisco, Calif. Details: ISA, 313 Sixth Ave, Pittsburgh, Pa.

May 9-12—Instrument Society of America, 2nd Instrument-Automation Conference and Exhibit of 1960, Civic Auditorium and Brooks Hall, San Francisco, Calif. Details: ISA, 313 Sixth Ave, Pittsburgh, Pa.

May 9-13—American Society for Metals, 2nd Southwestern Metal Exposition and Congress, State Fair

(Advertisement)

Hall Industrial Water Report

VOLUME 8 MARCH 1960 NUMBER 2

How to Increase Your Salary

Water's insatiable appetite for iron and other commonly used metals and alloys is costing industry many millions of dollars every year. Effective treatment of water to reduce corrosion to a minimum can save a substantial chunk of these dollars and route them into the till. Thence into the stockholder's pocket as dividends and into your pocket as a reward for cutting costs.

Hall engineers know how to treat water to combat its attack of metals. They can help you save many of the dollars that are being spent for maintenance and repairs because of avoidable corrosion.

Elusive Oxygen

Sodium sulfite feed for chemical fixation of residual dissolved oxygen in the boiler feedwater at a southern paper mill is usually less than twenty pounds per day. A sudden threefold jump in the requirement puzzled the operators. The increase in dissolved solids necessitated more blowdown which, in turn, increased requirements for other water conditioning chemicals.

When Hall engineer T. W. Hubner was called in, the symptoms indicated either trouble in the deaerating heater or bypassing of the heater with water high in dissolved oxygen. The second possibility was the easier to check.

A search by the operators then located the trouble. A valve in a bypass line was partially open which accounted for the difficulty. When the valve was closed, water conditions returned to normal. Experience enabled Hubner to steer the search in the right direction.

Luxury Pays Off

An aluminum fabricator was forced to reduce production several times per year for removal of corrosion products from inert gas coolers. Water treatment to control the corrosion in the cooling system had been considered. However, the operation was a small one and it was felt that water treatment was a luxury.

Hall engineers surveyed the cooling water problem and found that the cooling system could be protected at a cost of less than sixty cents per day.

Results have confirmed the findings. The annual cost of water treatment, which now permits uninterrupted production, is less than the previous cost of a single heat-exchanger outage.

Unusual Corrosion Problems

Peculiar corrosion effects sometimes result from contact of acid and steel. They are of interest because they might be encountered in connection with acid cleaning or in equipment used to store and handle acid for water treatment.

Although the rate of reaction between 66° Baume sulphuric acid and steel is substantially nil, it is greatly accelerated if moisture is picked up from the atmosphere. Bubbles of hydrogen, generated by corrosion, presumably become detached from the metal, rise and accumulate in contact with metal at such locations as horizontal pipe. Resulting erosive and galvanic effects impair the normal protective oxide coating. Narrow, but sometimes deep, grooves can be produced.

Hydrogen blistering has been observed near or just above the liquid level in concentrated sulphuric acid storage tanks and in pickled steel. Atomic hydrogen from corrosion diffuses through the metal. Where the hydrogen atoms meet something that catalyzes the formation of molecular hydrogen, the larger molecules cannot pass on through the metal. Accumulation of gas occurs and pressure becomes high enough to tear apart the metal grains. Failure tends to proceed along planes of stress which are predominantly parallel to the surface in steel plate, so characteristic gas blisters result.

Rain Water in Compressor Coolers

Decreasing supplies of surface and ground water in eastern gas fields have forced compressor operators to rely heavily on rain water storage to provide water for cooling system makeup. This has resulted in rapid corrosion of black iron pipe and formation of heavy organic deposits on heat-exchange surfaces.

Hall engineers were handed a tough assignment. Prevent corrosion and deposits in closed systems of steel, cast iron and copper containing a naturally aggressive water contaminated with oil, saturated with oxygen, at high temperature—and do this economically.

A corrosion inhibitor of the borax-sodium nitrite type, containing a special inhibitor for copper (Hagan Corrosion Inhibitor CS) has provided the answer. Current corrosion rates of both copper and iron are of the very low order of 1 mg/dm²/day. Chemical cost is about 25 percent of what it was originally. A bonus is emulsification of the organic material by the inhibitor with less accumulation of deposits on the heat-exchange surfaces.

Water is your industry's most important raw material. Use it wisely.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information on how the Hall System can help you solve your particular water problems, write, wire or call address below.

HALL LABORATORIES
HAGAN BUILDING, PITTSBURGH 30, PA.
Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.

This maintenance engineer is

"Seven eering" with R/M

to reduce downtime throughout the plant

At the recommendation of his local R/M distributor, he is installing Big 7 Packing Type #2 (high-temperature valve stem and expansion joint packing) because it is engineered to resist high temperature and pressure. R/M No. 325 high temperature valve stem packing is made of AAA grade, wire-inserted asbestos yarn over a plastic core which is free of organic materials. It resists temperatures of over 1000°F. A braided asbestos jacket gives added extrusion resistance.

When packing high-speed rotary air compressors, he will use Type #3—a metallic and asbestos packing that lubricates itself, maintains low friction, and runs cool in the absence of liquid.

Whatever your packing requirements, join the thousands of maintenance men that are "Seveneering" with R/M. They are using the Big 7 Packing Types to eliminate selection error and reduce inventory. They know that each packing is correctly engineered for the job it is to do. Frequently they find that three or four types will satisfy their needs without compromise in performance.

R/M Big 7 Packing Types are stocked by your local R/M distributor. Call him today. He is able to supply your needs immediately from his own stock, supplemented by any one of the strategically located R/M warehouses. And he will help you solve your packing problems.

This new R/M Big 7 Chart is a mighty handy reference. Send for your copy now.

BIG 7 PACKINGS

RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N. J.
MECHANICAL PACKINGS AND GASKET MATERIALS

Calendar

Begins on page 190

Park and Sheraton Hotel, Dallas, Texas. Details: A R Putnam, ASM, Metals Park, Novelty, Ohio.

May 12-13—Illuminating Engineering Society, Midwestern Regional Conference, Sheraton Martin Hotel, Sioux City, Iowa. Details: M Lee, Iowa Public Service Co, Orpheum Electric Bldg, Sioux City 4, Iowa.

May 16-17—Illuminating Engineering Society, Great Lakes Regional Conference, Carter Hotel, Cleveland, Ohio. Details: R D Churchill, General Electric Company, Nela Park, Cleveland, Ohio.

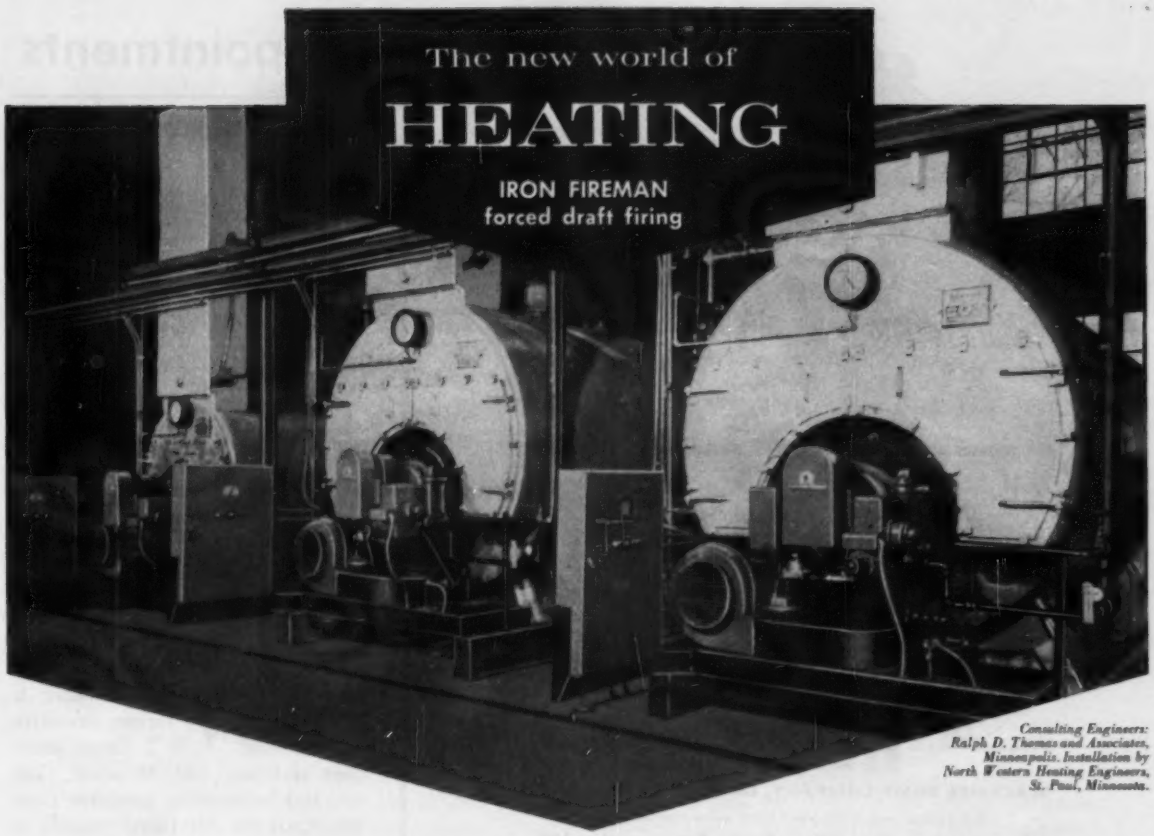
May 16-20—National Fire Protection Association, Annual Convention, Queen Elizabeth Hotel, Montreal, Quebec. Details: D Richardson, 60 Batterymarch St, Boston 10, Mass.

May 17-19—American Society of Mechanical Engineers, Production Engineering Conference, Schroeder Hotel, Milwaukee, Wisconsin. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

May 18-20—Society for Experimental Stress Analysis, Spring Meeting, Hotel Severin, Indianapolis, Indiana. Details: SESA, P.O. Box 168, Cambridge 39, Mass.

May 23-25—Instrument Society of America, 9th Annual Telemetering Conference, Miramar Hotel, Santa Barbara, Calif. Details: ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

May 22-26 — American Society of Mechanical Engineers, Oil and Gas Power Conference and Exhibit, Muehlebach Hotel, Kansas City, Missouri. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.



Consulting Engineers: Ralph D. Thomas and Associates, Minneapolis. Installation by North Western Heating Engineers, St. Paul, Minnesota.

This new heating plant increased boiler capacity 70%, yet will return the investment in 7 years

The Minnesota Masonic Home in Minneapolis faced a problem that is familiar to many owners of old heating plants—should the old plant be modernized or replaced?

After a thorough study of several alternatives, the engineering firm of Ralph D. Thomas and Associates recommended a complete replacement. The three Iron Fireman-Kewanee boiler-burner units shown above provide extra capacity for future needs, while cutting steam costs so sharply that engineers estimated they will pay for themselves in seven years.

COMPLETE, PACKAGED FIRING SYSTEM

The first big saving was in installation—the three units were moved in intact. No boiler settings, no brickwork, no special wiring required. The factory assembled units included boilers, burners, forced draft air supply, wired and tested control panels and fuel systems, all mounted on a permanent base. Low operating costs were the result of high combustion efficiencies (reduced fuel bills) and low maintenance. With packaged installation, factory responsibility covers practically the entire job.

FOR OIL, GAS OR DUAL-FUEL FIRING

Oil models fire any grade of oil from No. 2 to No. 6. Gas models take any type of high or low pressure gas. With dual-fuel models, fuels can be switched at a moment's notice with either manual or automatic controls.

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Iron Fireman Mfg. Co., 3054 W. 106th St., Cleveland 11, Ohio
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Please send complete technical description and specifications on Iron Fireman forced draft firing.

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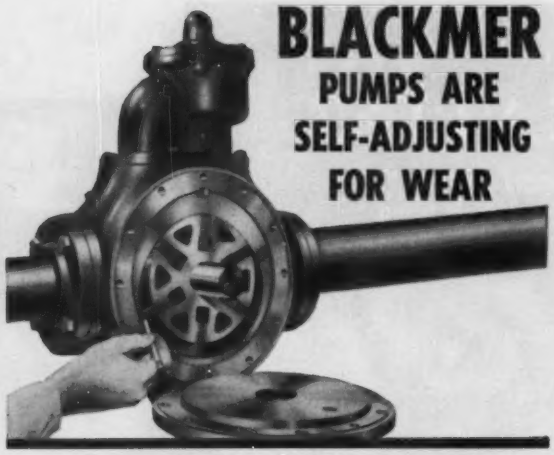
For more facts circle 335 on Reader Service card, p 109



BLACKMER PUMPS ARE SELF-ADJUSTING FOR WEAR

. . . . with the efficient sliding vane design

As wear occurs at the tips of these vanes, they move further out of the rotor slots to compensate for the wear. High pump efficiency is sustained until vanes are worn to the critical point. Even then they can be replaced easily and inexpensively. For more information, write for Bulletin One.

"liquid materials handling"® equipment

BLACKMER

BLACKMER PUMP COMPANY, GRAND RAPIDS 9, MICH.

See Yellow pages for your local sales representative

For more facts circle 336 on Reader Service card, p 109

The Nation's Big Industries

demand big power. When they need tube replacements fast, they depend on B. T. A.

BOILER TUBE COMPANY OF AMERICA

McKEES ROCKS, PA. (Pittsburgh District) Federal 1-7750

Appointments

Wesley A Songer

Crane Company's new president and chief administrative officer is Wesley A Songer, former executive vice-president. L H T Clegg, president of Crane, Ltd, Montreal, Canada had been acting president since last April 28. Mr Clegg remains as president of Crane, Ltd.

Songer has been president of American Safety Razor Corporation and has served on the president's staff of General Electric Company. He is a graduate of the University of Kansas and the graduate school of Business Administration, Harvard University.

Dr Robert C Langford

Daystrom, Inc, Weston Instruments Div will have Dr Robert C Langford as director of engineering. He succeeds Francis X Lamb, former vice-president of engineering. Mr Lamb has been named consultant to vice-president of operations at the Newark plant.

Dr Langford, former chief engineer for research and development at the Newark Operation, is a native of Portsmouth, England. He obtained his BS degree in 1944 from the University of London which he attended on the Sylvania-Thompson Scholarship awarded him by the Institute of Electrical Engineers. He was subsequently granted the Swan Research Fellowship and attained his

For more facts circle 337 on Reader Service card, p 109

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VALVES

performance makes the world of difference

POWELL HIGH PRESSURE VALVES

Gate, Non-Return, Globe, Angle "Y" and Check Patterns—all commercial sizes—for 150 to 2500 pounds and higher, for sub zero 1200 F. temperatures.

To handle the increasingly higher pressures and temperatures required by modern industry, Powell has the finest selection of quality steel valves with many exclusive Powell features of superior design and construction.

Many of these Powell Valves are stocked for quick delivery. Contact your city's Powell Valve distributor. Or write directly to us. Our engineers will quickly solve your industry's flow control problems in handling water, oil, gas, air, steam, corrosive fluids.

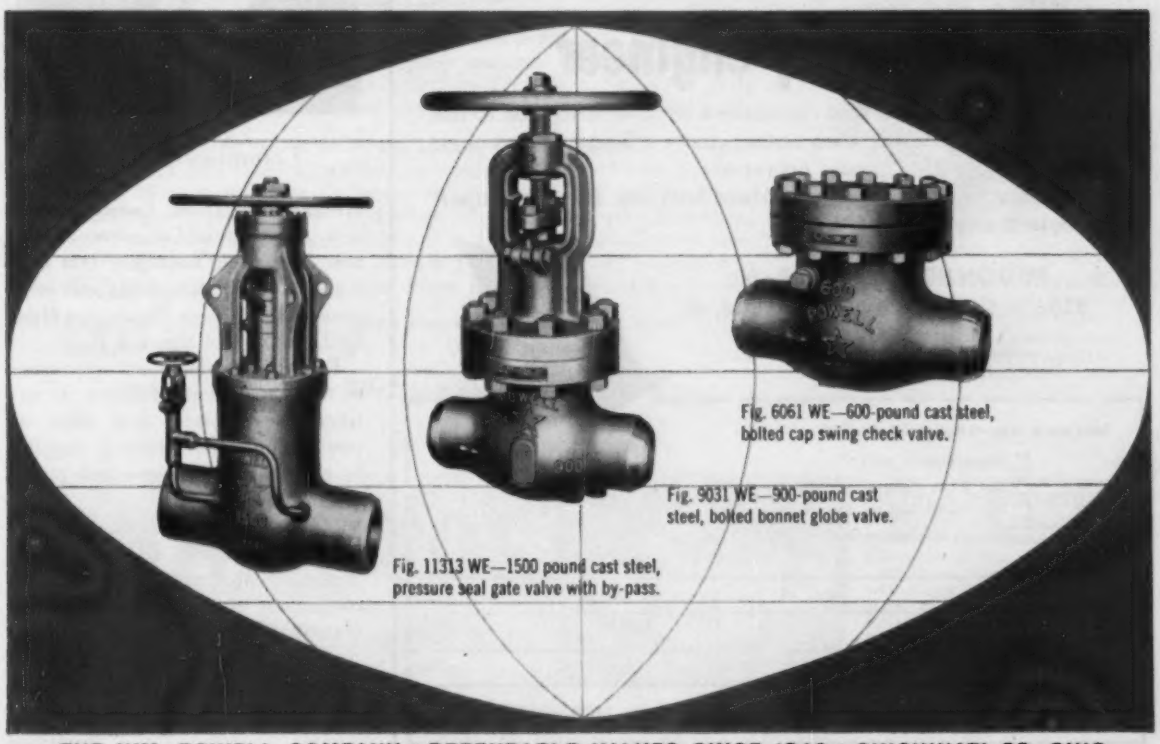
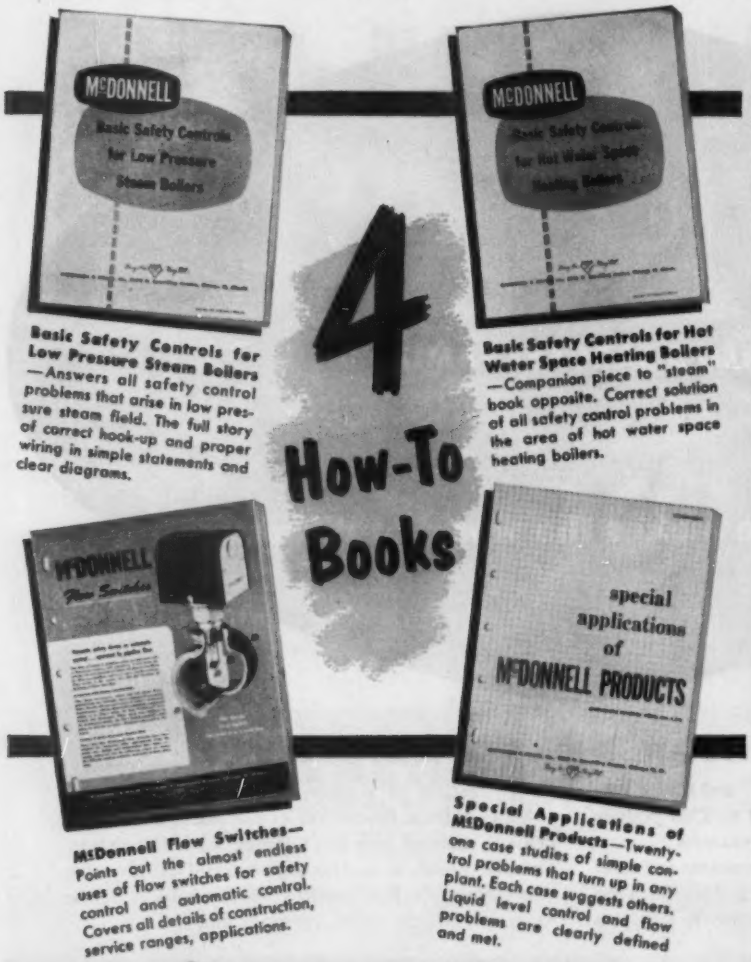


Fig. 6061 WE—600-pound cast steel, bolted cap swing check valve.

Fig. 9031 WE—900-pound cast steel, bolted bonnet globe valve.

Fig. 11313 WE—1500 pound cast steel, pressure seal gate valve with by-pass.

THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO



Basic Safety Controls for Low Pressure Steam Boilers—Answers all safety control problems that arise in low pressure steam field. The full story of correct hook-up and proper wiring in simple statements and clear diagrams.

Basic Safety Controls for Hot Water Space Heating Boilers—Companion piece to "steam" book opposite. Correct solution of all safety control problems in the area of hot water space heating boilers.

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Special Applications of McDonnell Products—Twenty-one case studies of simple control problems that turn up in any plant. Each case suggests others. Liquid level control and flow problems are clearly defined and met.

—for every engineer

Here are four bulletins that can make a basic contribution to the things every operating man seeks...more efficient operation... automatic operation...safer operation.

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- ☐ Special Application Booklet, ERS-A

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Appointments

Begins on page 200

doctorate from Queen Mary College.

As project engineer with Weston's affiliate in England, Sangamo-Weston, he conducted research projects on resistors, photoelectric cells, standard cells and general instrument design. Following eight years' service in England, he transferred to Weston as senior engineer. Dr Langford is holder of several patents on instrumentation, author of many papers and co-author on the subject in standard technical reference books. He is chairman of the Instrument Div of the AIEE in New York and Professional Group of Engineering Management of the IRE.

Columbus O'Donnell

Richardson-Allen Corporation's new president is Columbus O'Donnell, 33-year-old financier in the electrical and electronic fields and great grandson of George Huntington Hartford, founder of the A & P.

Richardson-Allen Corp specializes in the manufacture of silicon dc rectification equipment and other dc power equipment which it supplies to government, industry and public utilities.

O'Donnell purchased the 18-year-old firm in 1958. His assumption of the office of president marks the completion of reorganization he undertook from the date of purchase. He plans to increase the size of the company's existing facilities and double current production capacity.

continued

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with Unibestos reusable pipe insulation

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Everywhere . . . in refineries, power plants, process industries . . . once Unibestos is put to work, we have a steady customer. All we ask is a chance to show *you* how Unibestos can be constantly and effectively reused; how it resists impact and rough handling; eliminates shrinkage; defies thermal shock, fumes, acids and moisture; cuts application time and costs; and guarantees real insulating efficiency. Only Unibestos is made from the exceptionally long fibers of tough ***Amosite*** asbestos.

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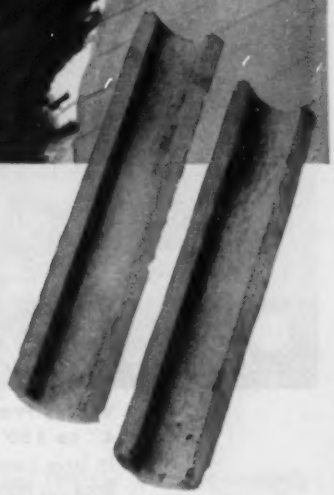

UNIBESTOS AFTER 25 REUSES

Unretouched photograph of typical sections of Unibestos pipe insulation after 25 reuses. Rugged qualities of Unibestos make reuse on changed lines or test lines standard operating procedure under all types of conditions.

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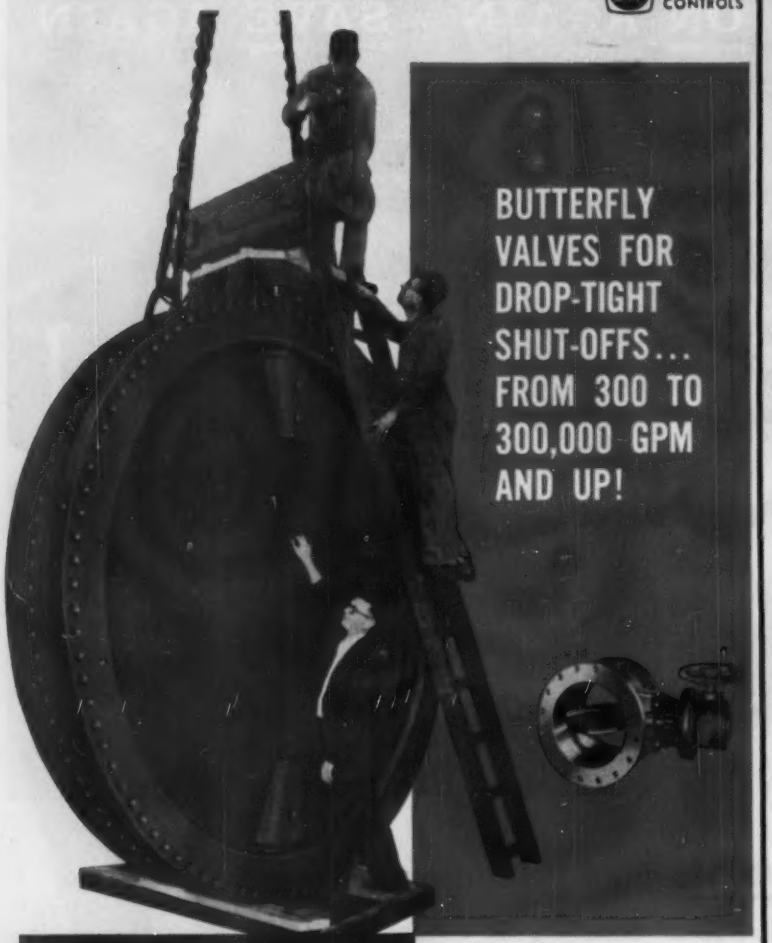

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In large condenser circulating water lines or small service lines . . . *reliability*, time after time, year after year! The direct result of over 75 years of manufacturing experience in the water equipment field.

Design prevents "freezing" . . . valves operate freely even after long periods of inactivity. Design is compact . . . cuts installation costs. Unique seat and bonding eliminates all leakage under pressures up to 125 psi. Available with all types of operators and in materials to suit your application.

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B-I-F Industries, Inc., 354 Harris Ave., Providence 1, R. I.

Appointments

Begins on page 200

Dr Leland G Cole

Beckman Instruments, Inc will have as new research vice-president Dr Leland G Cole. He joins Beckman Instruments after serving as chief research chemist for Consolidated Electrodynamics Corporation where he was responsible for direction of research concerned with new laboratory and process-control instrumentation. He was also responsible for the evolution of new products and establishment of Federally supported research and development programs.

In his new position, Dr Cole will be responsible for coordination of research and development programs conducted by the company's several operating divisions and for assistance in formulation and presentation of special government research and development proposals.

He received his degrees from Oregon State College. He was senior research engineer at California Institute of Technology and was later associated with the University of Michigan's Engineering Research Institute. Cole is the author of 40 patents, patents pending and technical articles in professional journals and government reports.

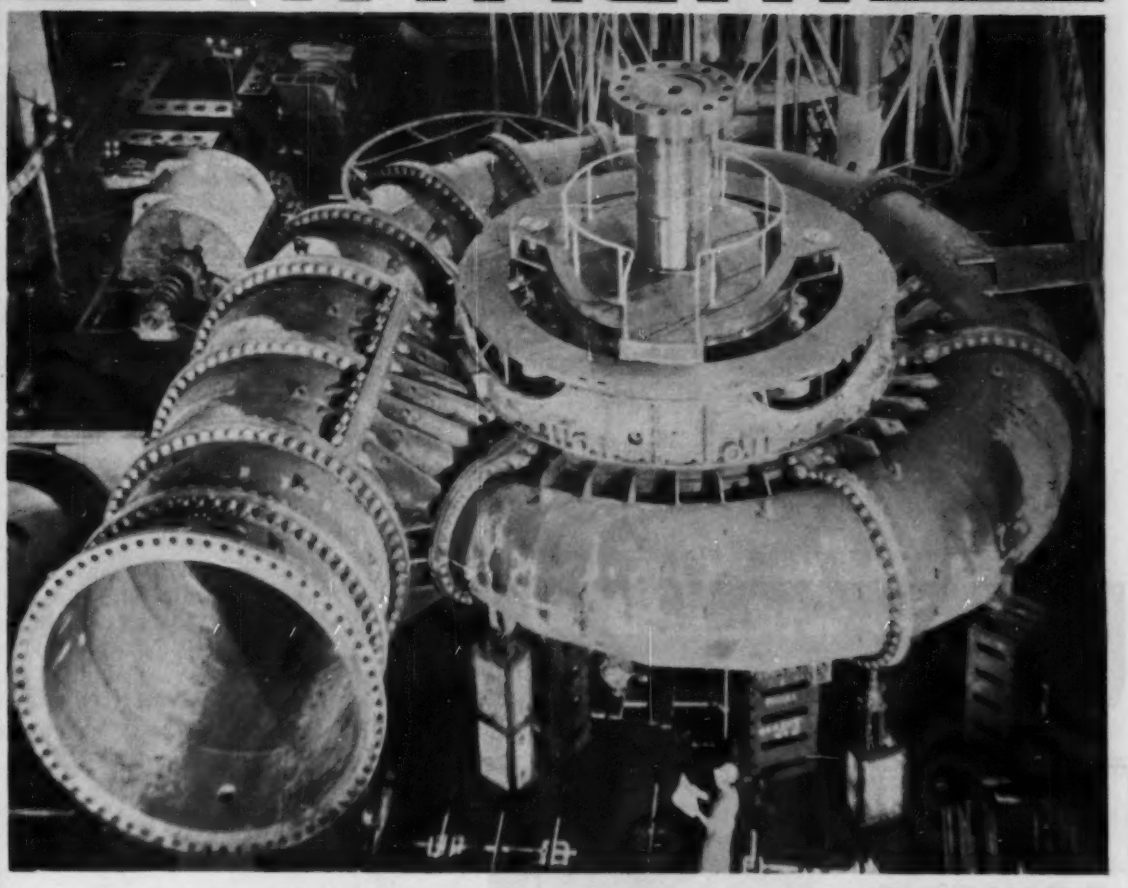
Institute elections, awards

Clarance B Campbell

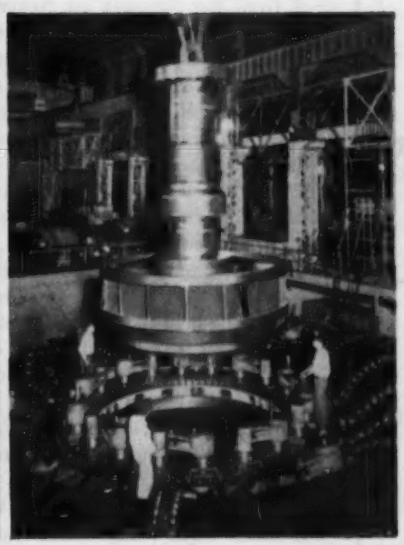
Westinghouse Electric Corporation's chief engineer of steam division, Clarance B Campbell, has been awarded the Gold Medal of the Newcomen Society in North America for his achievement in the utilization of steam for the benefit of mankind. The award was presented in January at the society's annual dinner.

This society perpetuates the name of Thomas Newcomen, the British pioneer who in the early 18th century contributed improvements to the newly invented steam engine. With headquarters in London, it centers its work in the history of accomplishments which have contributed or are contributing to the progress of

HITACHI



Another big Francis Turbine by Hitachi

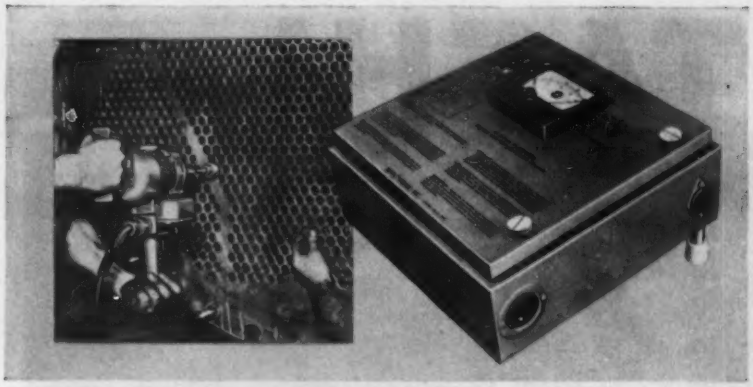


The completion of yet another big Hitachi job was recently marked by the successful factory tests of a 137,500 kw Francis Turbine. This is the first of a pair to be built, together with two 125,000 kva generators for the Miboro Power Station in Central Japan.

This vertical-shaft Francis turbine is specified for a speed of 225rpm, a maximum effective head of 200m and 76.6m³/sec water flow, making it one of the largest units of its kind in the world. Its runner has a maximum diameter of 3.7m and the main shaft a diameter of 95cm. The spiral casing, which was constructed in 13 sections to facilitate transportation to the site, has an inlet diameter of 3.35m and an outer diameter of 11.2m.

Hitachi, Ltd.
Tokyo Japan

Cable Address: "HITACHY" TOKYO



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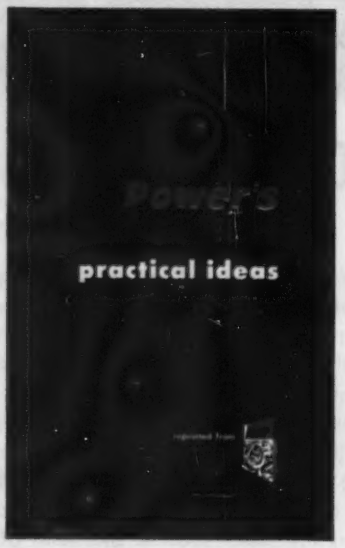

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Appointments

Begins on page 200

mankind. The Gold Medal is given in America approximately three times a decade. It was last presented to an American in 1956.

Campbell began as a technical apprentice in the Westinghouse steam division in 1919. He became manager of engineering in 1944 and was promoted to consulting engineer in 1952. Two years later he stepped into the position he now holds.

Campbell was graduated from the University of Michigan with a Bachelor of Science degree in mechanical engineering. He received the Westinghouse Order of Merit, the company's highest honor, in 1942.

American Chemical Society, Industrial and Engineering Chemistry Div: O H York, chairman. **Diesel Engine Manufacturers Association:** E L Miller, president; G Steven, W E Butts—vice-presidents. **Boiler Feedwater Studies,** Joint Research Committee: L D Betz, chairman; R A Lorenzine, vice-chairman.

Retirements

Philip D Reed

General Electric Company announced that Philip D Reed, chairman of the board for 19 years, retired from the company on November 30, 1959. Reed joined the company in 1926 as a vice-president's assistant. He became a member of the board of directors in 1938 and in the following year was elected chairman of the board.

Mr Reed received a degree in electrical engineering from the University of Wisconsin in 1921 and a Bachelor of Laws degree from Fordham University in 1924. Prior to his retirement he held the office of chairman of the finance committee of General Electric Company, having resigned as chairman a year ago.

William Brand, founder of William Brand & Company, Inc, after 40 years.

Charles W Kalbfus, editor of "Powerfax" since 1923, retires from

Westinghouse Volume Control helps pay off fly ash dust control investments

Operating mechanism is shielded from the gas stream but is readily accessible from the outside for inspection and maintenance

Westinghouse inlet vane air spin control is a *proven* low cost method of regulating Induced Draft fan output when using dust arrestors.

Many major power producers are using Westinghouse Inlet VANE CONTROL® on coal-fired induced draft fan applications, paying off their investment in dust control. Ask your Sturtevant Division Sales Engineer for a list of their names and installations — or, write Westinghouse Electric Corporation, Hyde Park, Boston 36, Mass.

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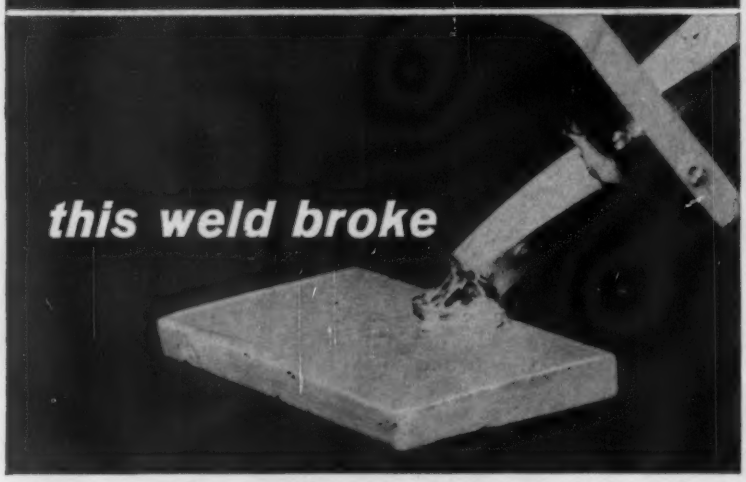
For more facts circle 345 on Reader Service card, p 109



(Above) This DRAVO TRU-WELD GRATING was deliberately bent, placing far more strain on the welds than there would be in normal service. Not a single weld has parted. This grating will withstand vibration and hard usage.

(Below) Bent in exactly the same way, this grating came apart at the welds. The fusion of bearing bar to cross bar achieved by the Dravo method of manufacture prevents this from happening to Tru-Weld Grating.

the new stronger grating is

TRU-WELD

Tru-Weld grating is stronger because it is *made* that way. Its added strength comes from a manufacturing process that completely fuses the metal at cross bar-bearing bar joints and holds the bars to exact spacing. The result is grating that stands up under excessive vibration, heavy traffic or in areas where corrosive fumes and moisture are a problem. And Dravo Tru-Weld grating *costs no more.*

Complete estimating, layout and fabricating services are available. Immediate delivery from stocks maintained at nearby Joseph T. Ryerson Service Centers will help you meet exacting construction schedules.

For more information on this new, stronger grating — call the Dravo representative in your area, or write Dravo Corporation, Pittsburgh 25, Pa.

DRAVO
CORPORATION

Appointments

Begins on page 200

the Elliott Company after 44 years.

Ray S Quick, consulting engineer at Eddystone Div, Baldwin-Lima-Hamilton Corp, after 40 years.

Carl A Schlegel, vice-president and member of board of United Engineers & Constructors Inc, after 49 years.

Obituaries

Harry R Clarage

Clarage Fan Company's president, Harry R Clarage, died suddenly after suffering a cerebral hemorrhage on December 26, 1959. He had been president of the company since 1945. Earlier he had served as salesman in the New York and Detroit offices and then as chairman of the board of directors.

The company was founded in 1872 by his grandfather, Thomas Clarage. Called Bird and Clarage Foundry and later Thomas Clarage and Sons, it manufactured steam engines, parts for fanning mills and generators for lighting plants.

Mr Clarage's father, Charles C Clarage, pioneered the company's development in 1913 as a fan manufacturer. Today the company deals in air-handling and air-conditioning equipment.

Mr Clarage's survivors include his widow, one son, three daughters and five grandchildren.

Edward P Bailey Sr, counsel and former president of the National Air-oil Burner Company, on January 4 at the age of 87.

Ludwig Charles Boos, vice-president of United States Rubber Company and general manager of its international division, on December 7. He was 56 years old.

John C Pangborn, co-founder of Pangborn Corporation, on December 24 at the age of 75.

Fredrick C Sammons, Los Angeles district manager of General Refractories Company, on January 16.

Rees F Tener, assistant chief of Testing and Specifications, National Bureau of Standards, December 25.

Know it by the yellow handle

Use it because it embodies features never before combined in a needle throttling valve . . .

It is the first throttling and shut off valve that serves the whole range of pressures—from low to 10,000 psi—with equal efficiency all the way through.

It is the valve in which body and stem guide are one piece—completely fused into an integral leak-proof unit by the exclusive Marsh "Conoweld" process.

It is the valve in which the stem is precision machined and ground. Perfect stem alignment and fine threads provide easy and precise throttling. Special "Marpak" packing always holds tight; never binds.

Bodies of the 1900 series identified by the yellow handle are machined from high grade carbon steel bar stock marked in accordance with M.S.S. regulations showing size, material and service. Stems are 416 stainless steel. Valves are available in the patterns shown below; sizes ⅛", ¼", ⅜", ½", ¾" and 1".

Marsh Needle Valves are also available in 416 stainless steel throughout (identified by green handles). *Write for bulletins.*

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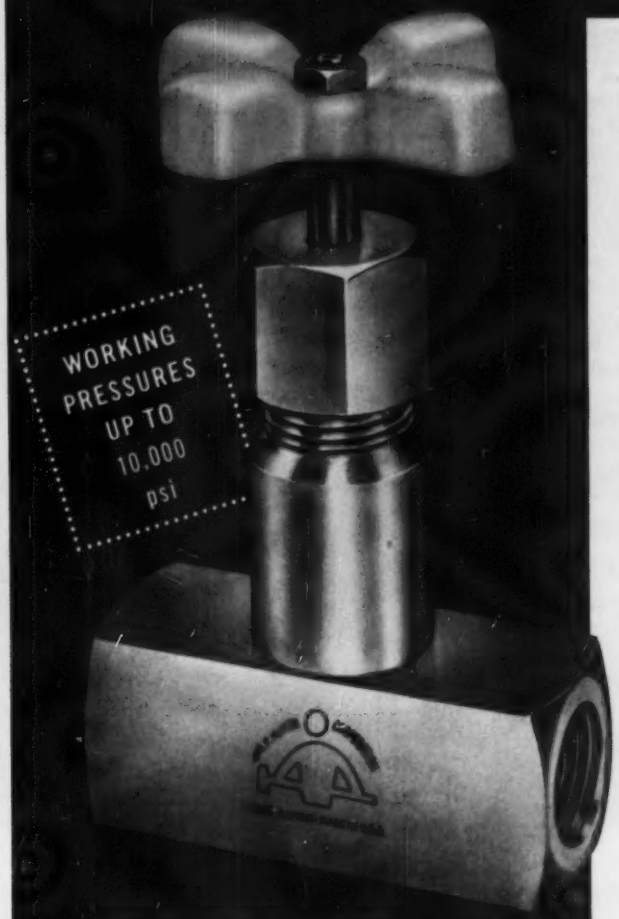
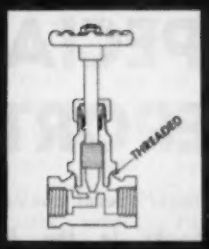
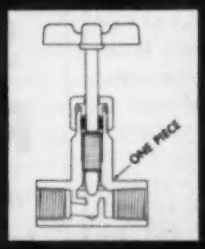
In stock at your nearest Supply House





Conventional Construction



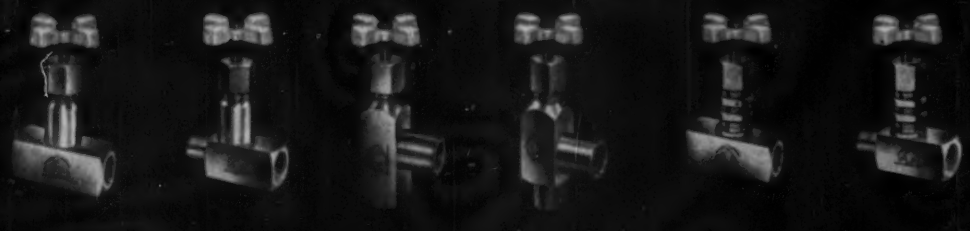
Marsh Construction

In conventional valve (left) stem-guide is threaded into body . . . can be backed out when valve is fully opened, causing real trouble when pressure is high. Can't happen with Marsh design (right). Marsh stem-guide is welded to body.

MARSH

SERIES 1900

Needle Valves



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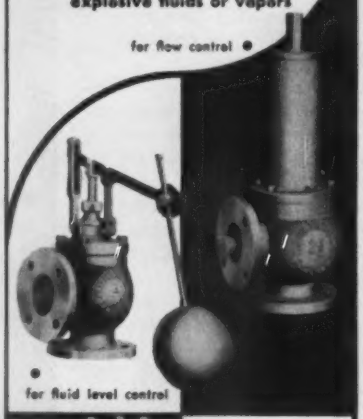
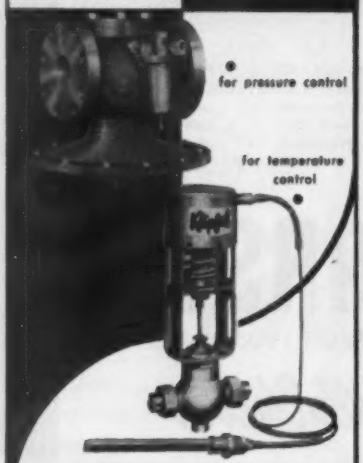


• for fluid level control



• for pressure control

for temperature control •

Special designs for application to original equipment. ENGINEERING

In writing for data please state your problem or describe your application. We will provide complete information.

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Bookshelf

Power Station Engineering and Economy (1960). *By B G A Skrotzki, Associate Editor of* POWER, *and W A Vopat, Professor of Mechanical Engineering and Head of Dept, Cooper Union School of Engineering. 761 pp, 6½ x 9¼, cloth, illust, tables, appendices, $12.50. McGraw-Hill Book Co, 320 West 42nd St, New York 36, N. Y.*

As the second edition of its predecessor, *Applied Energy Conversion*, this is an essentially new book, completely rewritten, updated and expanded. Original aim has been retained in this rewriting: emphasizing basic principles of operation rather than minute details of equipment design.

Five major divisions make up the book: (1) energy processing (2) steam-power plants (3) internal-combustion plants (4) hydro and meteorological plants (5) power economics. Part I deals with practical energy sources: coal, oil, gas, refuse and byproduct energy. Release of this energy by combustion leads to its transfer as heat into power cycles for processing the energy to shaft work. Chapters cover the principles of each of these important phenomena.

Part II builds on the basics of Part I in showing the applications to design and layout of steam-power plants. Each important element of the steam-power plant gets separate treatment: fuel-bed firing, suspension firing, steam generators, superheaters, reheaters, economizers, air heaters, draft systems, fuel and ash handling and dust collection cover the steam-raising aspects. Steam turbines, engines, condensers, heaters, evaporators, pumps, piping and heat balance cover the shaft-power-production end of the plant. Auxiliary systems covered in this part include: water conditioning, cooling-water supply and station controls.

Extensive chapters cover the new developments in supercritical-pressure plants and the first generation of full-scale nuclear power plants shortly to go in operation.

Part III shows application of basic principles in internal-combustion reciprocating engines and in gas tur-

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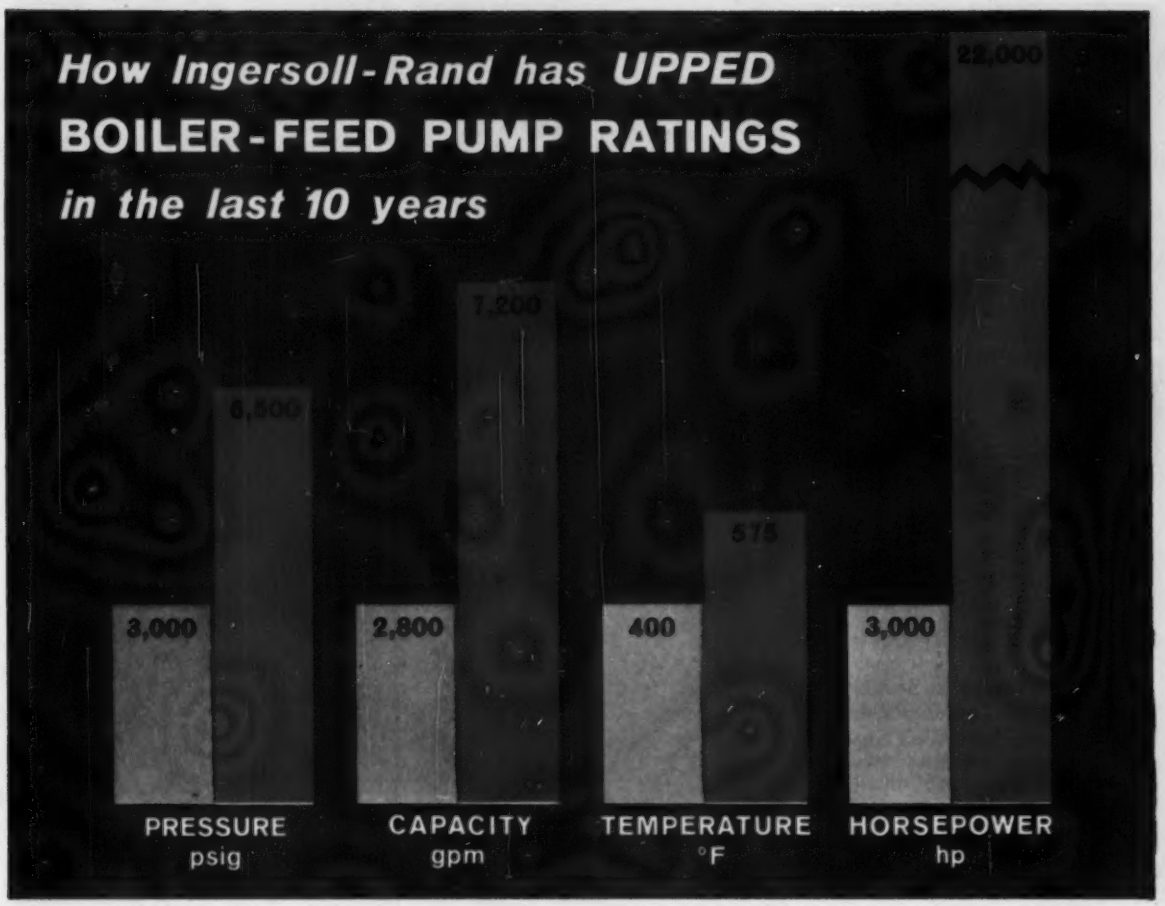

...to help power companies produce more kilowatts with better efficiency

In this chart of pump progress, none of the figures are theoretical. They are actual performance ratings of I-R boiler-feed pumps installed or now on order.*

The progress to higher and higher pump ratings has been made possible by improved design engineering, better metallurgy, improved manufacturing methods and advanced hydraulic research. To the user, it means simpler installations with fewer pumps to do a given job—higher operating efficiencies—better heat rates—improved steam plant performance and economy.

Combine this record of pump *progress* with Ingersoll-Rand's traditional *dependability*, and you'll see why Ingersoll-Rand is clearly recognized as the world's leading manufacturer of boiler-feed pumps. In short, this is why it always pays to discuss your pump requirements with Ingersoll-Rand.

11,000 horsepower boiler-feed pump undergoing performance tests in Ingersoll-Rand's new testing department. Pump is capable of handling 3600 gallons of feed water per minute at 4550 psig discharge.

**The figures shown do not represent limits of I-R boiler-feed pumps. If your particular application falls outside of the ranges shown, we would welcome the opportunity to discuss it with you.*

A CENTURY 1860 - 1960 ***OF PUMP PROGRESS***

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COMPRESSORS • GAS & DIESEL ENGINES • PUMPS • AIR & ELECTRIC TOOLS • CONDENSERS • VACUUM EQUIPMENT • ROCK DRILLS

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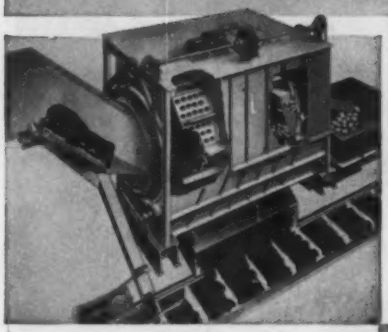
Rugged Cost Cutting Coal Processing Equipment

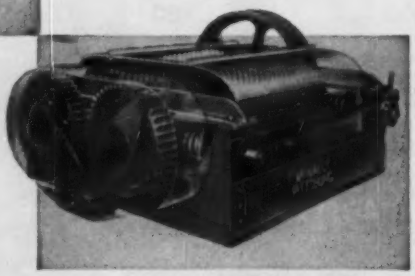


McNally Pittsburg Rotary Breaker

This heavy-duty unit allows positive control of top size in handling run-of-mine washery feed. Production of fines is held to a minimum. Without center shaft or spoke interference, costly maintenance is usually drastically reduced.

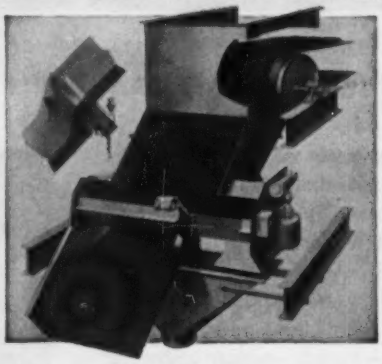
Gearmatic Stoker Coal Crusher

Built to handle heavy coal tonnages, these crushers have proved most efficient to reduce 8″ minus to stoker grades. They offer three major advantages: 1) high volume production; 2) accurate sizing; 3) low percentage of fines.



McNally Pittsburg Primary Coal Sampler

This automatic sampler (adjustable from 1 to 30 minutes) cuts out true samples of the coal stream. Cutter opening permits largest particle of stream to pass freely into cutter. Conveyor discharges into chute in which sampler is installed.



Ask the men who know coal from the ground up!

Your McNally Pittsburg man offers more than 37 years of experience in the preparation of coal. He can save *you* time and money in the selection of equipment to do your job more efficiently. *Write today!*

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Bookshelf

Begins on page 210

bines. Plant arrangements and auxiliaries needed by these units are described. Both spark-ignition and compression-ignition engines are covered. Various combinations of gas-turbine and steam-turbine cycles are studied.

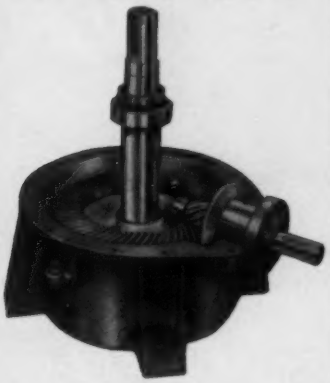
Part IV talks about energy in streams and falls, hydrological cycles, dams and headworks as applied to hydro plants. The various types of hydro turbines and their arrangement in plants are discussed. Feature of this part is the chapter on energy-source developments: solar energy, wind power, tidal power, wave power, low-thermal-head plants, geothermal energy, thermonuclear energy, fuel cells, thermoelectric and thermionic generators.

Part V continues to feature the only comprehensive discussion of economics applied to power-plant evaluation. Rearranged and augmented it gives a thorough grounding in the basic principles. Updating plant costs and added material on using probability methods in figuring plant capacity needed in a system make the book thoroughly modern.

Book closes with its well-known chapter on energy rates: their history and basic method of calculation. An added new and valuable feature is a 25-page appendix with charts and tables of important power-plant data. Practicing engineers as well as engineering students will find this a valuable practical reference book for their work.

"It's only until the pump is repaired, boys."

DESIGNED FOR TODAY'S HEAVIER FANS AND HEAVIER LOAD CONDITIONS



Take, for example, the 3400-CT Series spiral bevel cooling tower drives. They deliver efficiencies of 97 to 98 percent, while maintaining low operating temperatures. And special cooling systems are not needed.

Heavy duty housing construction and precision generated, case hardened Spiral Bevel Gears assure long service life. A high dome permits mounting fan directly on unit, with ample clearance for fan blades.

And a simple, fool-proof lubrication system, together with effective sealing devices to keep out moisture and contaminants, assure you of the outstanding performance, efficiency, and economy of operation you need to meet your requirements.

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Philadelphia cooling tower drives

Larger fans and higher load requirements in cooling towers require stronger, more dependable reducer drives. Philadelphia Gear has designed a series of spiral bevel, helical spiral bevel, and worm gear cooling drives in which the gears, bearings, housings, and supports are sized to withstand these increasingly severe conditions. Available in a full range of sizes and capacities, these rugged, built-to-last drives will give you long, trouble-free service with minimum maintenance requirements.

philadelphia gear drives

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Save time in getting Types 304 and 316 stainless condenser and heat exchanger tubes for new units or re-tubing jobs. Call your nearest Carpenter office for prompt delivery from large mill stocks of sizes ⅜" to 1" O.D. in 18 and 16 BWG. Stock lengths up to 40 feet are cut to your specific requirements. These full-finished tubes fully meet ASTM Spec. A-249. Besides, they pass the most searching nondestructive test applied to stainless tubing anywhere. This extra-close quality control is your assurance of getting the highest possible degree of perfection and dependability in Carpenter Stainless Tubes. That means savings in time, money and trouble for builders and users of heat transfer equipment.

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Stainless Tubing & Pipe

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SQUAT
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WITH PYREX® RED LINE GAUGE GLASSES... the ones that you can read from any angle or from a distance with ease and accuracy.

A red line permanently fused to the back of the glass is magnified by water . . . makes a sharp, clear mark you can read quickly and without error.

PYREX Red Line Glasses have the same pressure ratings as PYREX High Pressure Gauge Glasses . . . use them even in standard service to get that extra safety margin.

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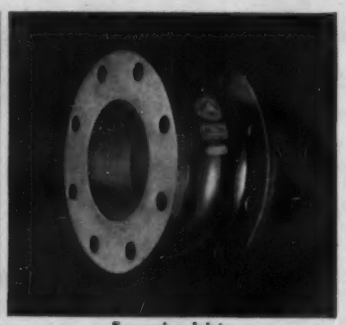
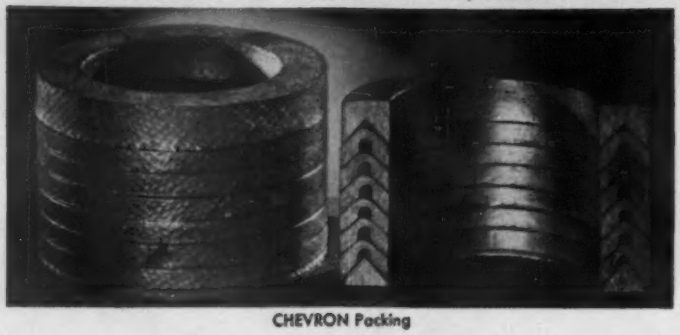


Expansion Joints



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Garlock GUARDIAN® Gaskets provide a safe, positive seal against high temperatures and pressures of steam, oils, gases, liquids. Gasket density, introduced during manufacture, assures dependable sealing under varying service conditions. Used at temperatures to 1050° F, pressures to 2500 psi . . . available in round, oval, square, flat side, diamond, pear and other shapes in practically any size. Large regional warehouse stocks are maintained at Camden, Cleveland, Houston, and San Francisco. Catalog AD-104.

Garlock All-Rubber Expansion Joints prevent noise and vibration in water and condensate lines. They react to the slightest pressure; this relieves any stress on expensive piping. Used against water, oil, mild acids, gases, and exhaust steam. Will withstand temperatures to +180 °F, pressures to 125 psi. Garlock has Rubber Expansion Joints ¾" to 84" in dia.; in round, rectangular, tapered, and offset spool types or U types. Catalog AD-137.

Garlock CHEVRON® Packings assure positive, low friction sealing on rams, plungers, reciprocating rods. Designed to tighten as pressures increase, ease off as pressures lessen . . . this means minimum friction at all pressures. Available in many materials for temperatures ranging from −320° F to +600° F. Catalog AD-115.

For more information, contact the nearest of Garlock's 26 sales offices

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Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products

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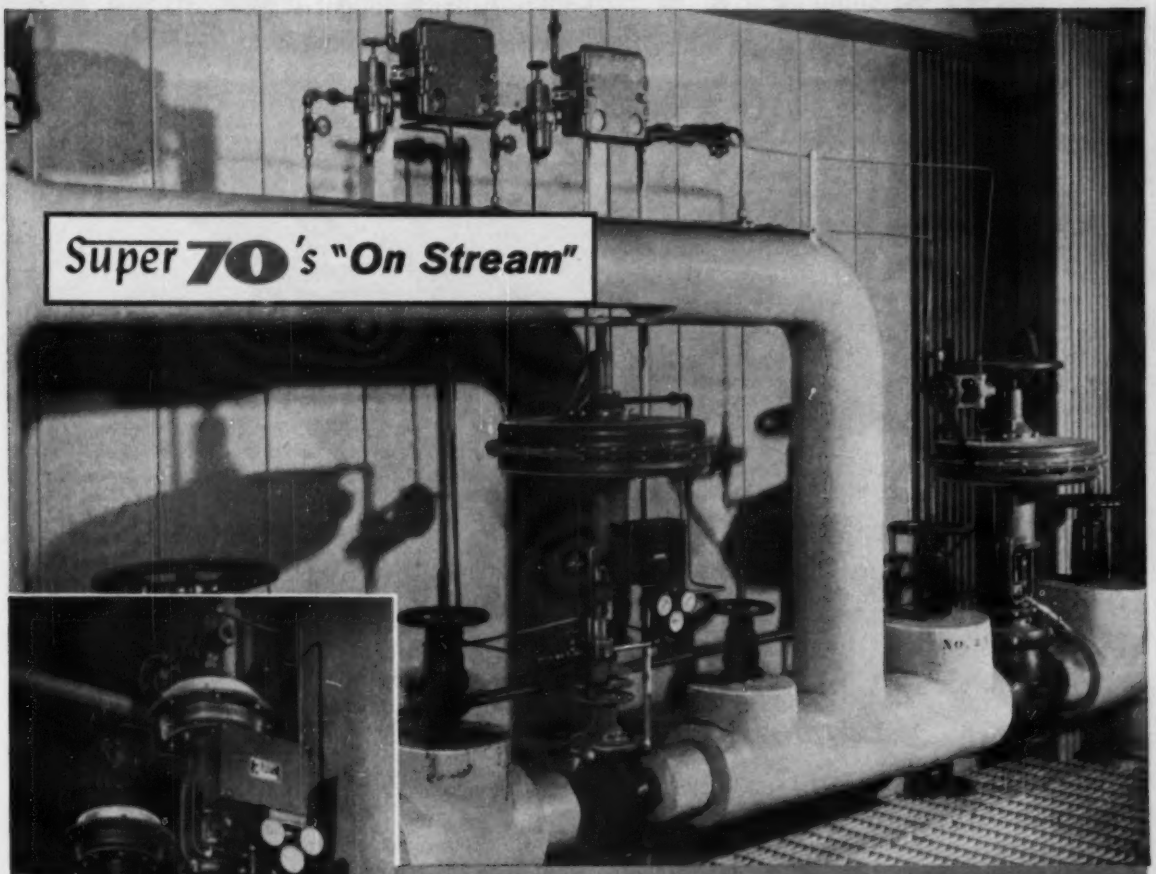

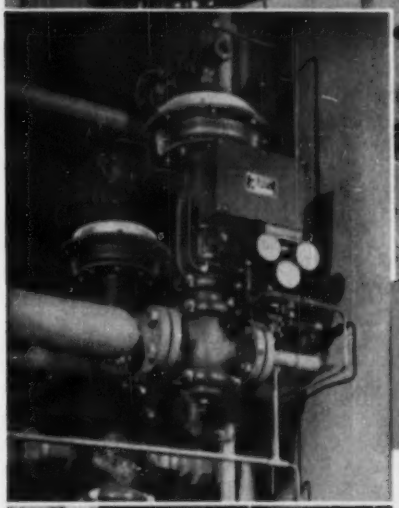

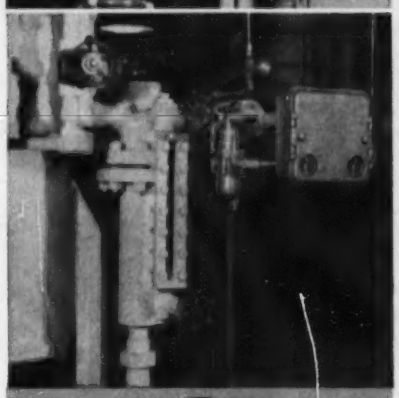

Power Plant With A Forward Look!

Playing an important role in the operation of this modern, efficient power plant located at Escanaba, Michigan, are seventeen BS&B Super 70 Diaphragm Control Valves with clamp ring-float ring body closures. The plant, operated by the Upper Peninsula Power Company, is also equipped with BS&B Liquid level controllers, pilots and air regulators.

Super 70's are available for power plant applications in a complete range of sizes with either clamp ring-float ring or flanged-gasketed body closures.

Next time you have a new station "on the boards", specify BS&B Controls right down the line. They're dependable, efficient, and cut down maintenance costs. You'll get application engineering assistance, too!

SUPER BS&B 70

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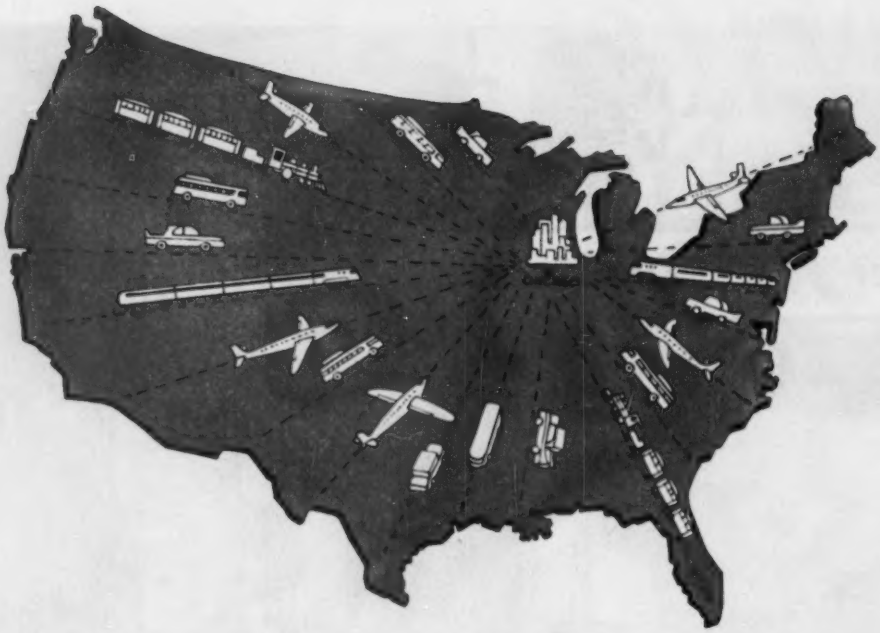


George Edwards

asks: Can you afford to miss this?

Toward the end of this month a flock of engineers are going to head for Chicago for an annual get-together. I'd guess that, without exception, they'll be looking forward to another exciting, thought-provoking experience. In this they're not going to be disappointed, judging from the preview I've had of the tentative program lined up for them.

I'm talking about the 22nd Annual Meeting of the American Power Conference scheduled for March 29, 30 and 31. This 3-day meeting will include some 95 papers and addresses devoted to all aspects of the power industry. For many, the highlight of the technical program will be the forum involving discussions of unconventional methods of generating electricity. Included will be subjects such as magneto-hydrodynamics, isotopic heat and power, the fuel cell and the nuclear rocket program.

Scanning the program, in general, is like looking down the menu in a first-class restaurant. You're so hungry you could eat a horse, and everything sounds scrumptious. But you can't eat the works, so it leaves you with a tough decision. In cramming such a tremendous program into a 3-day meeting, necessity dictates scheduling several tasty subjects at simultaneous periods. Be that as it may, you can bet your hat that there's a full-course meal in store for every appetite.

Speaking of meals, there's apt to be little elbow-room at lunch on Tuesday, March 29. ASME's president, Walker Cisler, is going to present some eye-witness impressions of "An American engineer in Russia." You'll remember that Walker spent some time touring power facilities in the Soviet Union. What Russia is doing in the power field is worth, and is getting, plenty of attention from our people. Soviet brass (who else but Mr K?) has his whip out and, as Lou Rowley pointed up last month, (*"K" speaks out on power*, Feb 1960, p 57) he's clearly a man in a hurry. Action spurred by his new 7-year plan is reflected by the papers being published by his engineers and scientists. (Examples: see *Technical briefs*, p 104).

Another straw in the wind is Seymour Melman's recent report of Soviet activity in the machine-tool industry. Professor Melman, associate professor of industrial engineering at Columbia University, warns in effect that if the West doesn't soon convert to mass-production methods in line with those used by the Russians, we're going to be left well in the shade so far as world markets are concerned.

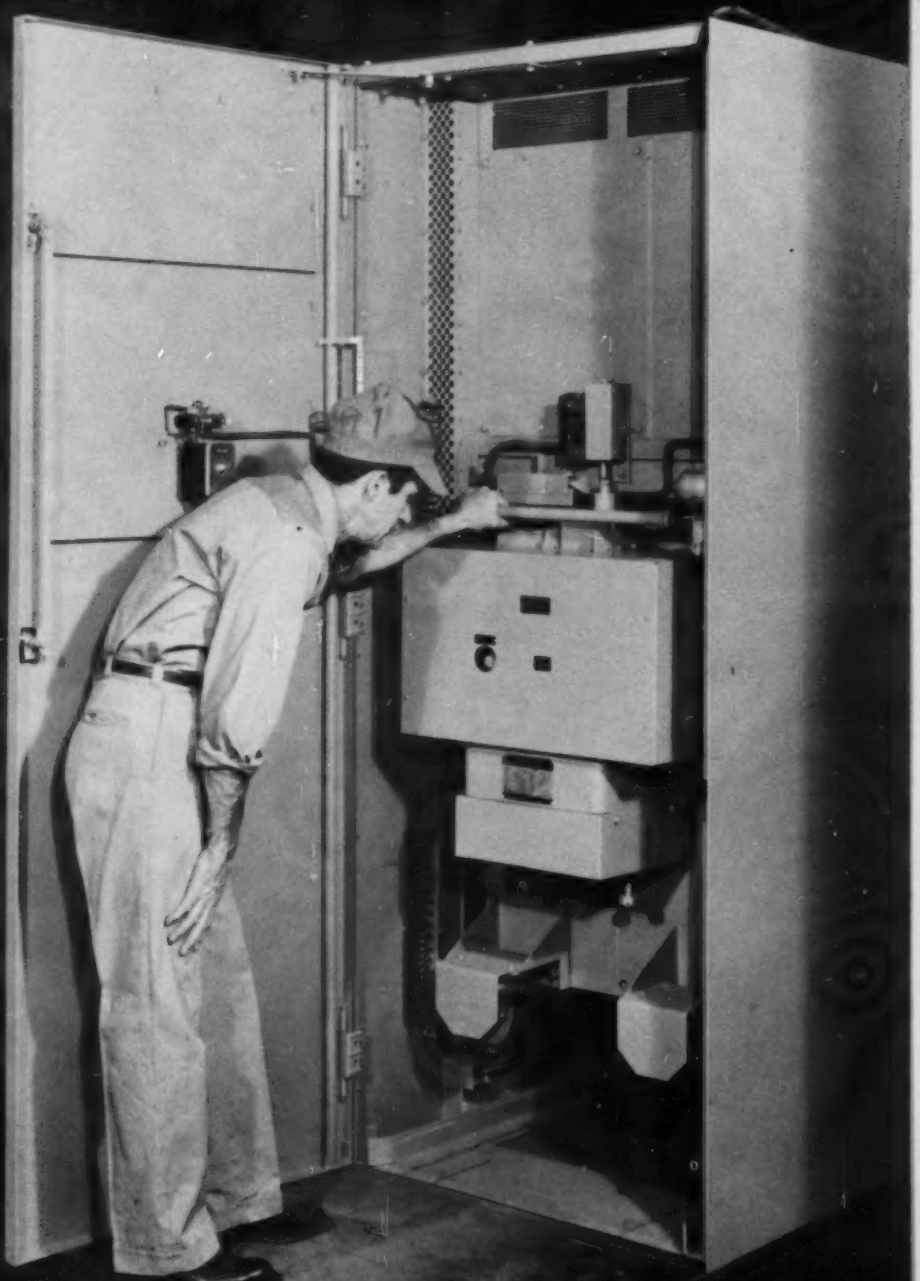
Basic machine tools such as automatic lathes, milling machines and boring mills are being produced in a third the number of man-hours, and at half the price, of similar machines made in Western Europe and the United States. We can point out, of course, that our wage scale and standard of living are mainly responsible for these differences. But we've got to narrow the gap to keep these benefits.

No accident, this detour from talking about the American Power Conference to what's going on in Russia. Soviet engineering advances present a real challenge. In Chicago, you'll see proof of what our country's engineers are doing to meet it.

circle 357 on Reader Service card, p 109 ➤

Change hats
with your maintenance man, he will demonstrate...

WHY GENERAL ELECTRIC MANUFACTURES ONLY *Vertical Lift* METAL-CLAD SWITCHGEAR



Follow these
3 easy
inspection steps

GENERAL ELECTRIC

General Electric manufactures ONLY Vertical Lift Metal-clad because...

General Electric's exclusive *Vertical Lift* design gives you superior switchgear performance... these operational benefits

1 Visible circuit breaker safety protects your personnel — helps prevent wasteful outages

General Electric Vertical Lift is the only switchgear design which allows your operator to actually *see* when the primary disconnects are parted . . . a safety bonus that also reduces the possibility of costly equipment outages.

Safety you can see is a prime reason why General Electric manufactures Vertical-Lift design Metal-clad switchgear.

2 One minute contact inspection saves you costly maintenance time

General Electric Vertical Lift design lets your maintenance man expose the contacts in just one minute for cleaning, inspection, and adjustment. This efficient maintenance reduces your operating expense. Quick, easy contact servicing that contributes to the over-all economy of General Electric Metal-clad installations is another reason why General Electric manufactures Vertical Lift design switchgear.

3 Up-front location of operating mechanism cuts your installation, maintenance costs

G-E Vertical Lift design gives you another cost saving through placing the breaker operating mechanism and controls up front. Even the stored energy operating mechanism is mounted up front for easy access, reducing maintenance time and expense.

4 20-minute routine maintenance means less service man-hours — more productivity

Under normal conditions, your maintenance man can remove G-E Magne-blast breakers from their housing, give routine maintenance, and return them to service in 20 minutes. General Electric's exclusive Vertical Lift design contributes increased switchgear efficiency —in both operating and maintenance phases—to your Metal-clad switchgear installation.

5 Magne-blast circuit breaker action gives you effective system protection

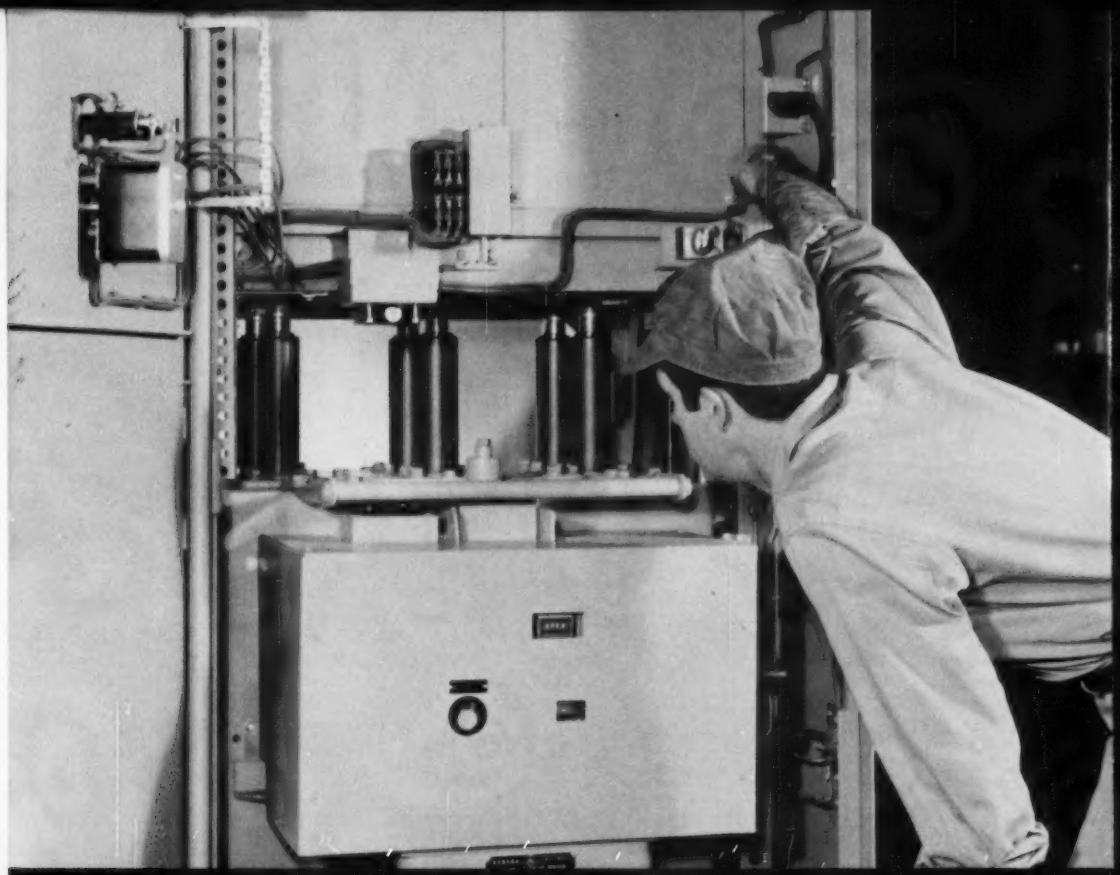
General Electric's Magne-blast breaker design gives you positive, three-phase interruption and fast, clean arc extinction — a combination that assures high reliability, top switchgear performance. Extensive factory quality control, and testing at full-rated interrupting capacity maintain the uniformly high operational standards of G-E Vertical Lift Metal-clad switchgear.

Both General Electric assemblies and Magne-blast circuit breakers are shipped completely assembled. This service feature results in greater safety for personnel and reduced installation time and expense.

G-E Metal-clad is available in voltages from 4.16 to 13.8 kv, and in interrupting capacities from 75 to 1000 mva. This full range of voltages and capacities enables you to select switchgear "tailored" to your present or projected system needs . . . yet you pay no premium for special engineering or construction, thanks to many conventional ratings.

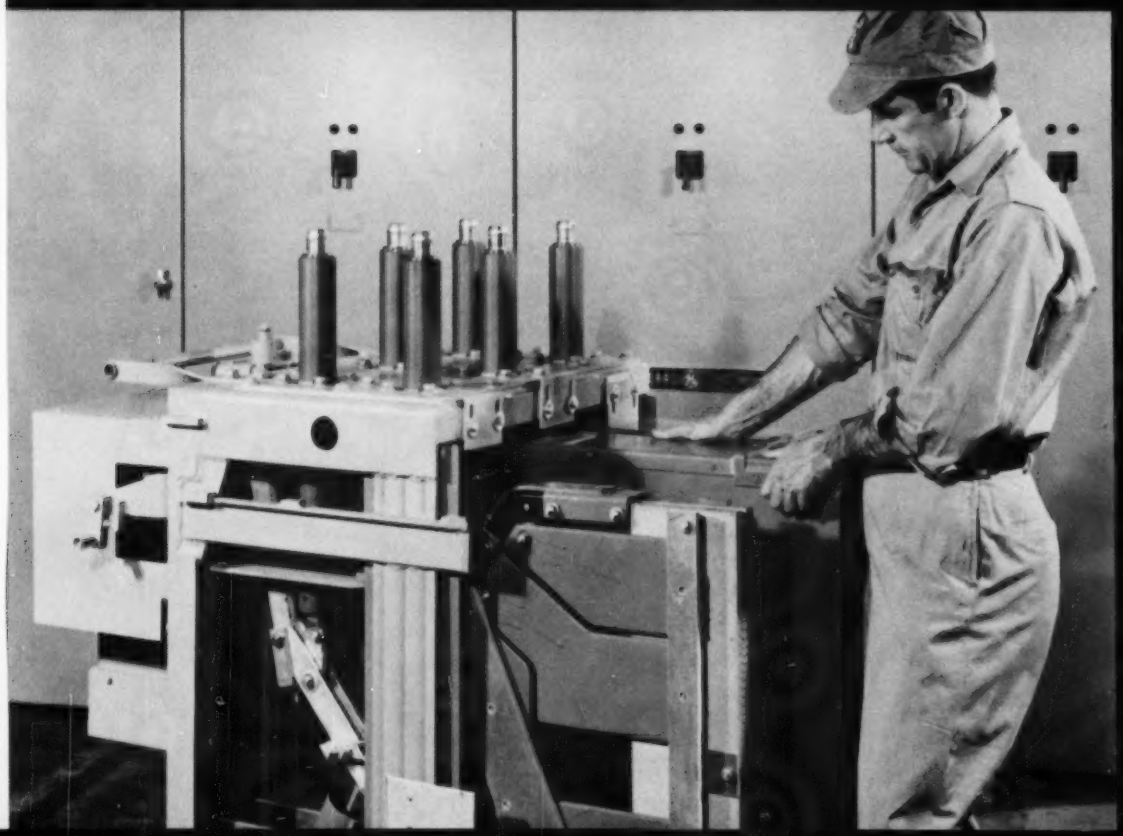
FOLD OUT FOR STEP 3 ▶

GENERAL ELECTRIC



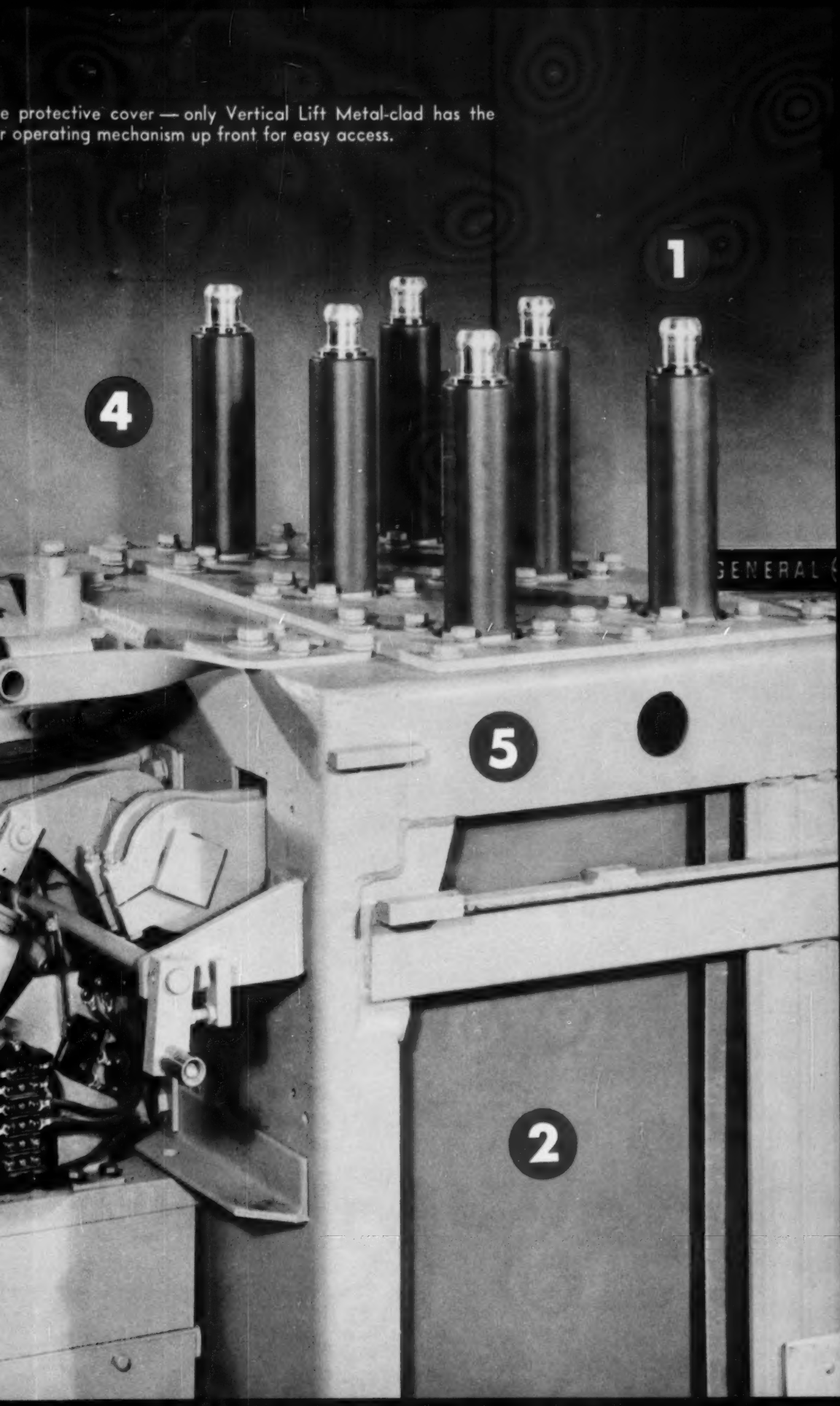
Disconnect breaker automatically—only Vertical Lift design permits operator to actually see when disconnects are parted.

Remove breaker, box barrier — Vertical Lift design allows operator to inspect contacts without removing arc chutes.



STEP 3:
Remove pr
breaker op
3

e protective cover — only Vertical Lift Metal-clad has the
r operating mechanism up front for easy access.



In addition to exclusive design features...

G-E application and service engineers pre-engineer your Metal-clad switchgear installation... give continuing service

The first step in the extensive service you receive with General Electric Metal-clad switchgear is the expert problem-solving and planning assistance from your G-E sales engineer.

Next, G-E application engineers study your system, offer suggestions for efficient, economical installation, and monitor project progress.

G-E guide-form specification sheets simplify the ordering of Metal-clad switchgear units — your engineering expenses can be reduced through the use of this General Electric system planning assistance.

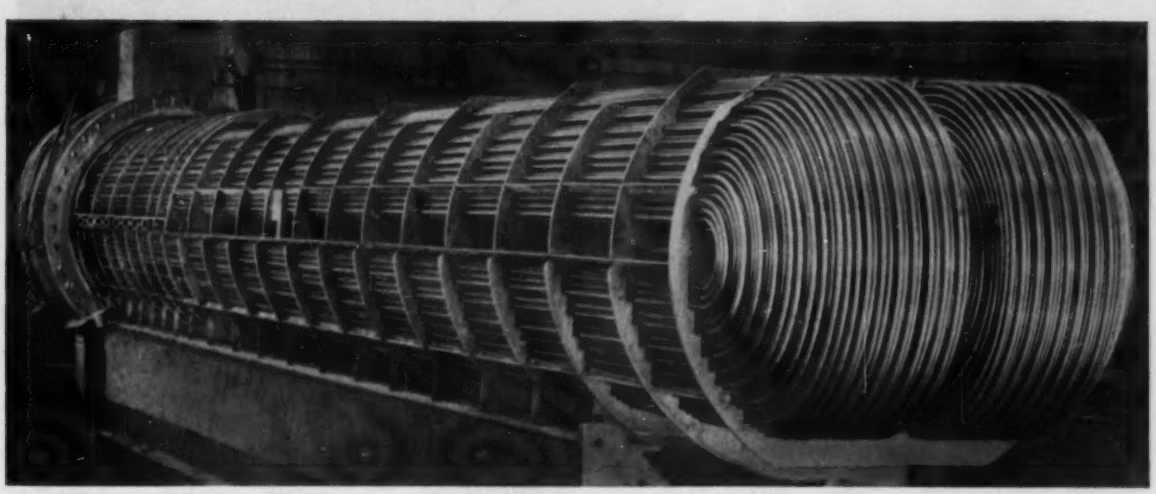
When necessary, your Metal-clad equipment is inspected and test-checked at the time of installation to assure a satisfactory hook-up to your power distribution system.

When you plan a new or expanded system, call in your G-E sales engineer early so that he can give you maximum assistance in satisfying your switchgear needs. Write for this detailed switchgear bulletin — GEA-5664E, to Section 511-36, General Electric Company, Schenectady 5, N. Y.

Contact your General Electric switchgear representative for more information about your best buy — G-E Vertical Lift Metal-clad switchgear

Progress Is Our Most Important Product

GENERAL ELECTRIC



What kind of tubing do modern feedwater heaters need?

Tubing for today's feedwater heaters must be strong to handle higher pressures and temperatures in modern steam plants. It must be made of a corrosion-resisting metal with good heat transfer properties. It must be workable and weldable to permit bending and attaching to tube sheets. In addition, it must insure long, trouble-free service.

There's one tubing material – Monel* nickel-copper alloy–that offers all these advantages:

- **Higher design stresses.** Without increasing tube wall thicknesses, stress relieved Monel tubing can be used for higher pressures. The latest revision to ASME Boiler Code, SB-163, allows an increase of approximately 5% in existing design stresses.
- **Better all-around corrosion resistance.** Monel resists corrosion by waters of all sorts.
- **High ductility.** Monel has good ductility for rolling and bending – permits unannealed tube ends. High ductility means tight rolled joints, and ease of forming hairpin bends.
- **Easy weldability.** Welding Monel alloy tubes to steel tube sheets is no problem. The alloy fuses well to form a strong, sound weld. Its coefficient of expansion is close to that of steel tube sheets.
- **Product quality.** Continual inspection and testing from refinery furnace to finished form result in the unvarying quality of Huntington Alloy Products tubing.
- **Long length tubing available.** The automatic cold draw bench at Huntington Alloy Products mill makes Monel tubes *as long as 85 feet!* This enables designers to take advantage of greater heating area in the tube bundles, and to effect economies by specifying longer heaters of smaller diameters.
- **Prompt deliveries.** With new facilities in full operation, prompt deliveries of your Monel tubing requirements can be assured. Special attention will be given to retubing jobs, where prompt delivery is important. Orders are accepted on a basis of 8 week delivery.

Keep Monel alloy in mind when you design or retube a high pressure heat exchanger. For more information on Monel and other dependable high nickel alloys, write for "Standard Alloys for Special Problems." *Trade trademark

HUNTINGTON ALLOY PRODUCTS DIVISION
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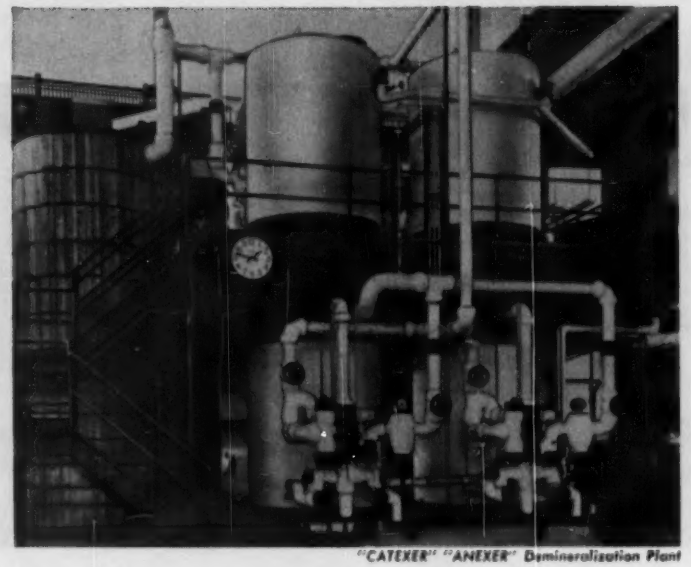
MONEL.®

For more facts circle 358 on Reader Service card, p 109

Your boiler feedwater problem is different!



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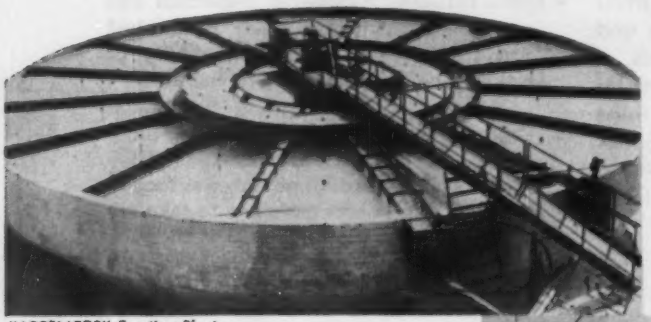
That is why INFILCO offers you a complete range of water treating plants custom engineered to meet your particular requirements. For example–

If you use high pressure boilers, you might require a CATEXER® ANEXER® Demineralization Plant. These plants give you improved make-up quality, adequate supply regardless of station electrical load, reduced overall operating costs, and lowered maintenance costs and labor expense.

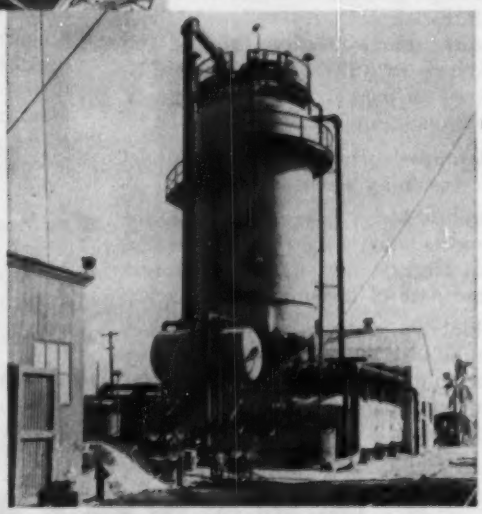
For low pressure boilers, the ACCELATOR® Treating Plant offers a most economical means of treating feedwater. It is also frequently recommended for pre-treating make-up water for high pressure boilers. "ACCELATOR" Clarifiers and Softeners have a proven record of flexibility and ease of operation.

Feedwater for intermediate boiler pressures can often be treated by INFILCO Hot Process Softeners. These softeners are noted for their accurate treatment control and superior performance. They are often used in combination with Hot Process Zeolite Softeners.



"ACCELATOR" Treating Plant

Whatever your feedwater problem, you can depend on the complete engineering know-how and many years experience that have made INFILCO a leader in this field. Why not submit your problem today. INFILCO engineers will suggest a practical solution. Write for information.



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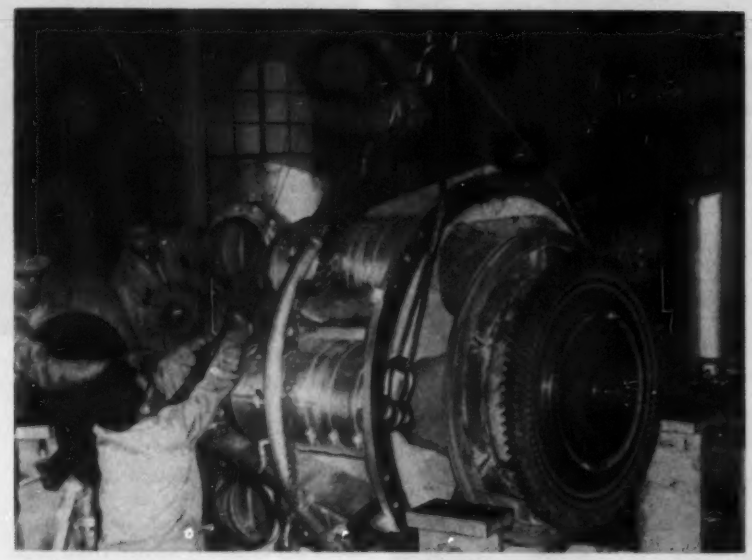
Plant maintenance and management section

STEVE ELONKA
Associate Editor in Charge



MAJOR OVERHAUL of gas turbine and centrifugal compressor is routine. All parts get visual inspection plus series of nondestructive tests. Complete data are checked, recorded

One million fired hours' experience proves dollar value of . . .

Test gear for gas-turbine maintenance

By A H CARAMEROS
El Paso Natural Gas Co
Southern Division

Picture yourself as a plant superintendent with years of experience operating relatively slow-speed reciprocating engines. You know them like the palm of your hand and, as you move among them day after day, you're on top of any potential trouble spot in less time than it takes to tell it. Because of this know-how, your engines purr as they roll over all day long.

Let's suppose, now, that one day you're asked to superintend operation of a completely different plant. Tomorrow morning you're going to walk across the plant yard and into a new engine room. Here, instead of the familiar reciprocating engines, you're faced with a battery of sleek, powerful gas turbines. They're hooked up to centrifugal compressors, not the piston type unit you're as familiar with as the old engines that drove them. As you stand in the doorway looking over these modern babies, your mind races back over the practical knowledge you gained in years of experience with reciprocating engines plus what you learned about these units while they were being installed. You think of the blading with tips moving at blinding speed

BALANCE MACHINE installed in central shops is big item in preventive-maintenance program. Routine checks such as this put an end to compressor-bearing failures

ELECTRICAL CONTROLS get routine check by team member in charge of performance

and with almost microscopic clearances. Component wear that you could have gotten by with on the old engines for perhaps a few weeks could force you to shut down these machines.

The new machines have the last word in controls to facilitate operation by one man per shift. A far cry from your old engine room where manual operation was the order of the day. But as you look over the control board, and as you listen to the high-pitched whine of turbines and compressors, you're confident that you're on top of the situation because you're backed up by an operation and preventive-maintenance program that's practically foolproof.

This picture, while perhaps slightly exaggerated, is one we lived through when our company shifted from large slow-speed engines to gas-turbine-driven centrifugal-compressor units to pump natural gas through our transmission system. Today, some six years later, we've logged more than a million fired hours on a total of 32 machines in 12 stations and we're understandably proud of our relatively trouble-free record. The lessons we learned during these past six years may, we believe, help other gas-turbine operators.

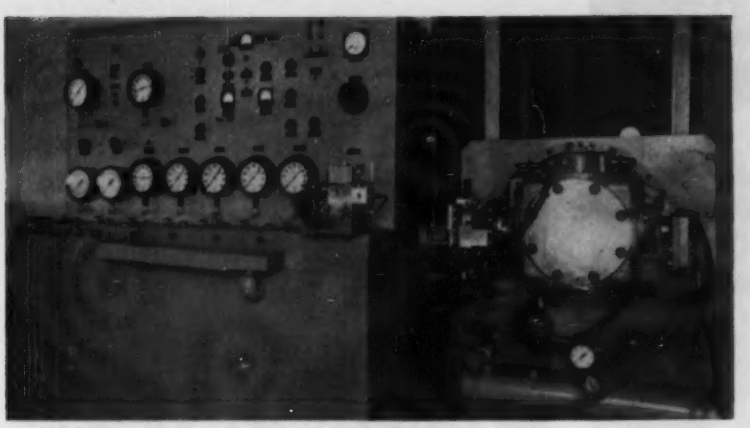
Our new equipment's actual operation was relatively simple so long as we had no trouble. Operators' main duties were recording operating data, reporting these to the dispatcher and keeping the plant clean. However, training given them by the station superintendent (who was with equipment during construction) in putting machines on and taking them off the line considerably increased the operators' value.

Biggest problem remaining to be solved was maintenance and troubleshooting. Solution was training several technicians and engineers to assist in the program. At first only a superintendent and four operators were included in the plant organization. Then, need for another operator and maintenance mechanic became apparent. These men were added to fill in when others were ill, on vacation, and for routine jobs.

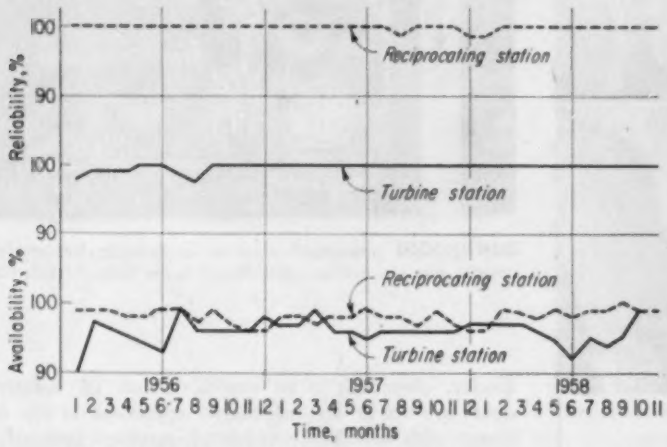
Maintenance man is second in command of the plant. Aside from minor maintenance duties, he may, on occasion, pitch in on a major overhaul. In an emergency he can take over plant operation. Our program includes: (1) Electricians, each of whom serves several plants for routine maintenance and, in emergencies, is responsible for trouble-shooting and repair of electrical power-supply and control equipment. (2) Instrument men, who maintain and troubleshoot all plant instruments, pressure gages and pneumatic controls. (3) Mechanics, foreman supervised, do all major overhauls on turbines and compressors. Foreman usually has six men, and a major overhaul means that every part of turbine and compressor is inspected visually, with dye penetrants, magnetic particles and X-ray. All clearances and dimensions are checked. A company engineer records these data plus machine's condition, with photos if needed; his report is used for comparison at the next overhaul.

Troubleshooters, final members of the team, step in when needed to give plant personnel a hand. They diagnose and correct trouble, calling on other team members if necessary. The entire team, trained to the hilt to do their job at the outset, recommended purchase of some mainte-

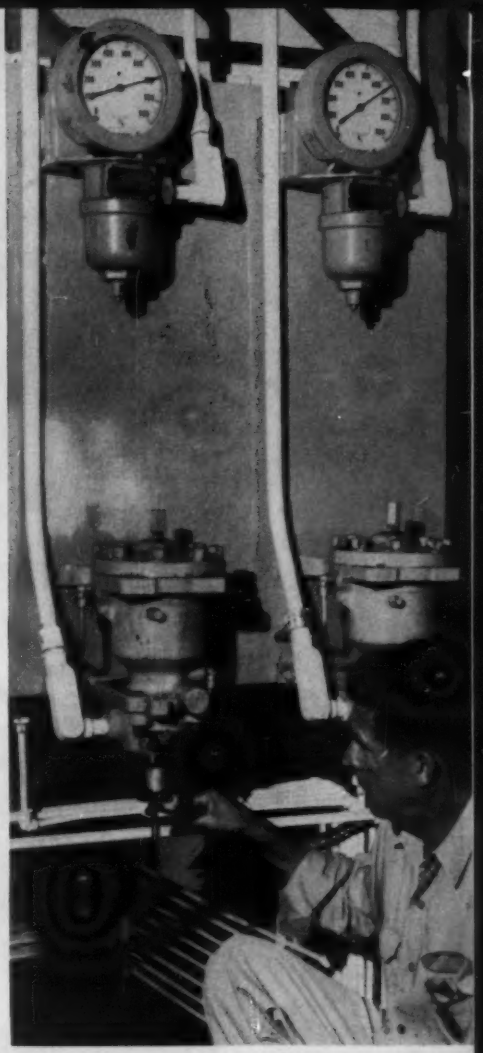
personnel are keys to minimum outage time



FUEL-CONTROL-SYSTEM adjustments are made on this gas-turbine simulator instead of on machine, cutting expense and downtime. System can be tested, repaired and modified



AVAILABILITY-RELIABILITY comparison shows gas-turbine and compressor performance as opposed to other equipment. It's result of personnel teamwork



PLANT INSTRUMENTS, pressure gages and pneumatic controls get constant care

nance equipment to help them provide continued trouble-free operation.

First item acquired was a balance machine which quickly proved its worth. It improved equipment performance tremendously, cut costs and allowed units to stay on the line for longer periods without maintenance. Compressor - bearing failures were soon to become nonexistent.

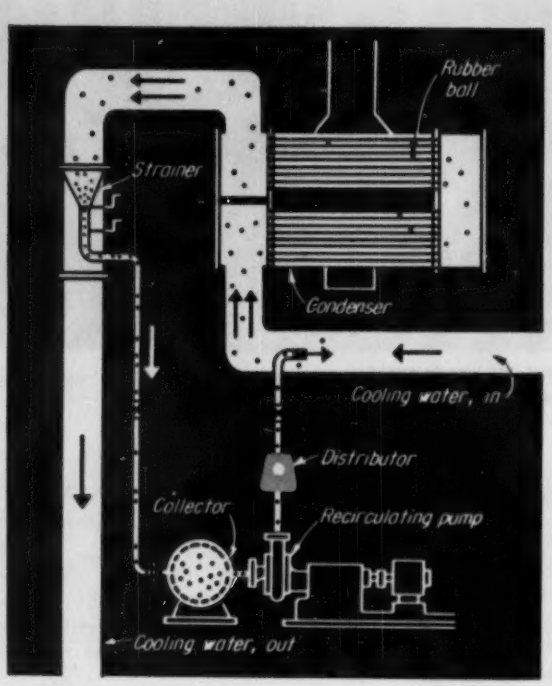
Fuel - control system adjustments were time-consuming and expensive if they were done on the machine. Too, delay in returning the equipment to the factory slowed our maintenance program and indicated need for more spares. This problem gave us some real headaches until we solved it by building a gas-turbine simulator on which a fuel-control system could be installed, tested, modified and repaired as needed. Then, with minor adjustments, the fuel-control system could be installed on a machine in the field with a minimum of expense and downtime.

Our maintenance and test facilities, in which the balance machine and the gas-turbine simulator play major roles, have considerably reduced outage time and improved overall station performance for El Paso. And the stations, acting primarily as boosters but not limited to this application, are doing a big job. Capacity through the southern system is about 1 billion cu ft per day; crossover's capacity is about 500 million cu ft of natural gas per day.

We've demonstrated that the gas turbines and centrifugal compressors have achieved a reliability and availability comparable to any existing equipment on the company's line. We like to think that a big reason for this is our program's excellent technicians, maintenance men and operating personnel.

OPERATORS' NOTEBOOK 137

Condenser



CONTINUOUS mechanical cleaning is done by rubber balls pumped into circulating water. Water forces balls through tubes

Rubber ball squeezes through tube, cleaning as it goes

Sponge rubber has proved the best material for this condenser-cleaning setup. Porosity of rubber allows water to enter each ball. This keeps ball clean, makes its specific weight same as water's, to insure that balls go through all condenser tubes within a certain time.

Balls must be larger than ID of tubes. The larger the ball, the greater its cleaning effect—and it lasts much longer. But there is a limit: maximum diameter depends on pressure differentials between inlet and discharge of the condenser tubes. Diameter and elasticity of balls must be balanced carefully—you can't have balls sticking in the tubes, but you do want best-possible cleaning effect. Only 90 to 180 gpm are needed for recirculation in system.

Today, downtime is so expensive that all industrial sights are set at keeping major equipment at top efficiency without taking it out of service. Boilers are cleaned by shot bouncing from tube to tube—*Operators' notebook* No. 135, Jan 1960. Condensers, too, are getting an in-service-maintenance look. Amertap Corp of New York, N. Y., representing a West German firm, has a condenser-cleaning system that pumps rubber balls through your condenser right along with the circulating water.

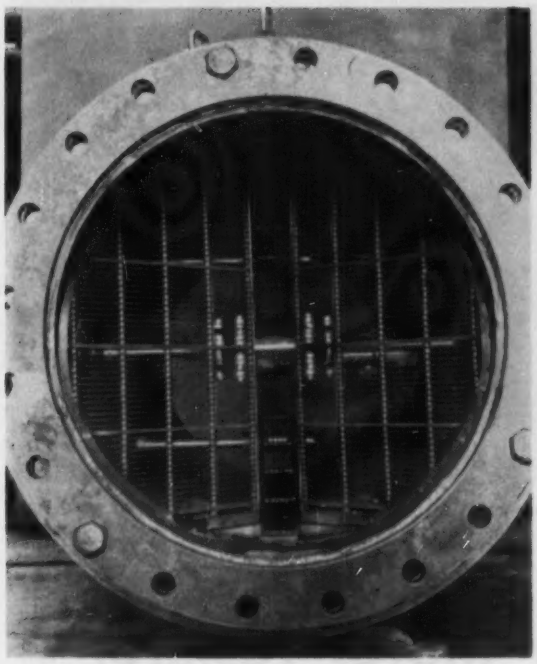
Balls are forced through the tubes and leave with the discharge water. Then a strainer removes them from main flow of water. They're piped to a recirculating pump, pumped back into the inlet line five to ten ft from the waterbox, sketch above.

Savings. Each drop of 1/10-in. backpressure is worth a cool $6000 per year to a 100-mw steam plant. This size plant would use a system carrying about 600 sponge-rubber balls. As balls wear out, fresh ones are added daily, just like boiler makeup water. Twenty new balls added to a large system each day will do the job. At present cost of $12.50 per 100 balls, that means $75 per month or $900 a year for clean condensers.

In large plants it takes about three years to amortize cost of installation in fuel savings. And this is done by

tubes stay clean in operation

By STEVE ELONKA, Associate Editor



CLOSED STRAINER separates rubber balls from discharge cooling water, draws them into small recirculating-water pump

pumping rubber balls through the system only two hours out of each 24 hours that plant is in operation.

Unique feature is that tubes *stay* clean, never have to be cleaned chemically. They're serviced mechanically while condenser is in full operation. Efficiency of any heat exchanger naturally depends on condition of the tube surfaces—this firm guarantees that tubes will maintain same degree of cleanliness at all times.

To install this self-cleaning system, you connect the circulating water lines on inlet and outlet sides of the condenser by smaller water lines, just large enough to carry the balls. A small recirculating pump is hooked up between inlet and discharge lines, with enough head to overcome differential between inlet and discharge sides. This pump operates only during the cleaning process, keeps balls in circulation by pumping them back into the inlet side of the condenser.

Balls remain suspended in cooling water until they enter a condenser tube. Then they are compressed inside the tube and forced through by differential pressure. Experience shows that when there's enough pressure difference between inlet and outlet ends of the cooling tube to force a compressible ball through the tube, ball will do a fine cleaning job on the way. Of course the balls must be the proper size, see box at far left.

Entire surface of the tube is cleaned, and laminar layer of relatively still water close to the tube surface, where most scale forms, is wiped off the surface. Any small particles tending to adhere to tube walls are also wiped off before they have a chance to build up.

Strainer in the discharge line, photo, left, separates balls from cooling water and draws them toward the recirculator. Strainer allows water to pass out without effective pressure loss to the system—total resistance of strainer during normal operation won't exceed 6-in. water column. Suspended porous balls, saturated with water, are injected into the circulating-water inlet line against the flow. They're introduced at enough distance from condenser itself to insure distribution over the entire tube sheet. During cleaning process, not more than 5 or 10% of tubes will have balls going through them at one time.

Balls are porous for better service. They eventually wear down; then they're either removed from system or squeeze through the strainer and discharge from the system automatically.

Equipment. Strainer in circulating-water discharge line is made of corrosion-resistant profiled steel bars. It can be backwashed by turning tops of upper and lower screen sections toward center line of the discharge line. Circulating water washes away all the debris.

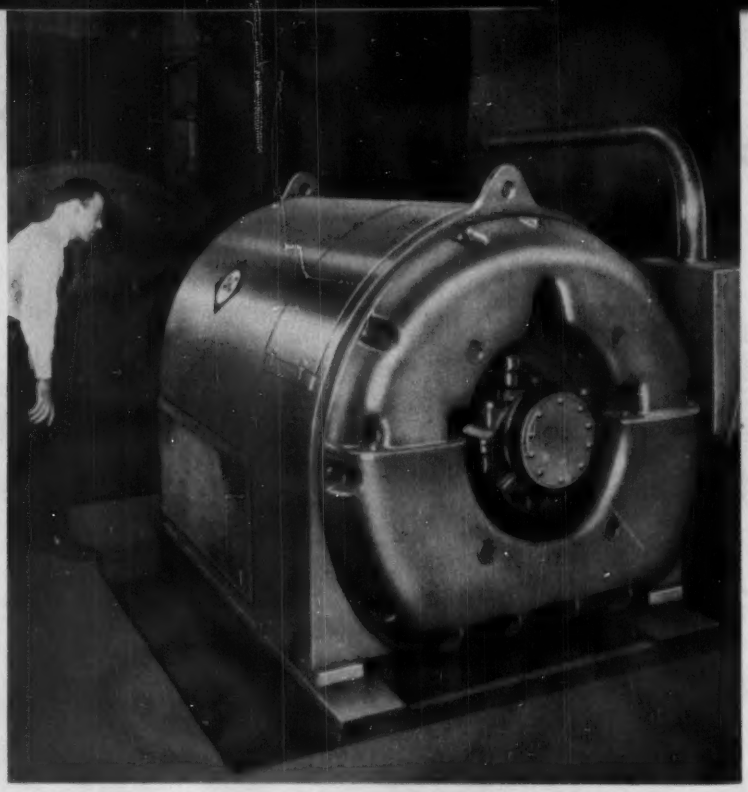
When cleaning process is over, balls are carried from the strainer to a specially constructed continuous flow collector, which collects balls while allowing water to pass through. When all balls have been collected, valves are closed, the recirculating pump stopped and cooling water drained off. Then the balls can be taken out, inspected and if necessary replaced.

Continuous flow collector has a glass port, a connection for draining and a connection for air release to vent air from the pump. Glass port opens for access.

Recirculating unit is a single-stage centrifugal pump with tubular rotors. Ample clearance prevents damage to the balls. Power needed for pump is two to three horsepower. From pump the balls go to the distributor, which either distributes them to two inlet circulating-water lines, or insures a better distribution through one large inlet line. This distributor has a sight glass to check circulation of the balls and is regulated manually. Circulation of the balls can be stopped at any time by collecting them in the continuous flow collector, closing the valves and stopping the recirculating pump.

Here are advantages claimed for system: (1) Fuel savings from increased vacuum (2) power savings for circulating-water pump due to less flow resistance (3) no stopping and starting turbine for condenser cleaning (4) no expense for cleaning condenser manually (5) more running hours per year for turbine (6) longer turbine life (7) higher total output of power station (8) increased tube life and (9) low maintenance costs and easier handling because equipment stays on line.

By R C MOORE
Allis-Chalmers Mfg Co



WOUND-ROTOR induction motors are often used to drive pumps, fans and similar loads where variation in speed may be desired to alter output load, lessen erosion of impeller, etc

Choose wound-rotor motor resistor

. . . that gives you best speed and torque characteristics. Calculation shortcut uses only nameplate data and rotor-winding resistance

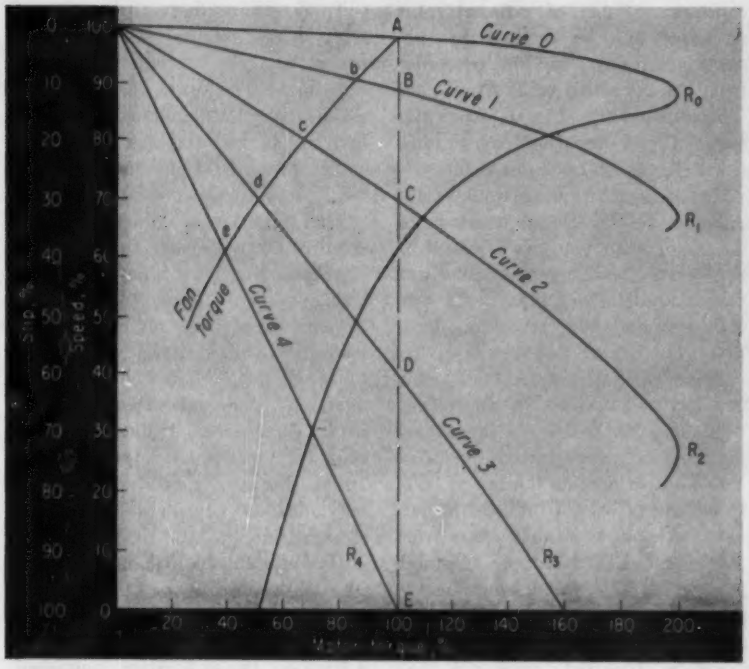
Important characteristic of a wound-rotor motor is that you can change its speed under load by varying the value of resistance connected across the slip rings. You can use the motor equivalent circuit to determine value of external rotor resistance needed to obtain a desired motor speed for a given load. However, equivalent-circuit calculations can be tedious, requiring motor-design constants not readily available. For many types of wound-rotor speed-regulating duty a shorter way of finding rotor external-resistance values will do the trick. This short method requires only that you know nameplate data and rotor-winding resistance.

Rotor resistance influences current and torque of a wound-rotor motor. At full voltage a squirrel-cage induction motor has only a single speed-torque curve, determined by rotor or cage winding resistance. Such a curve may be similar to curve *O*, next page. Curve *O* also represents a wound-rotor motor operating with slip rings short circuited, except that standstill torque may vary widely.

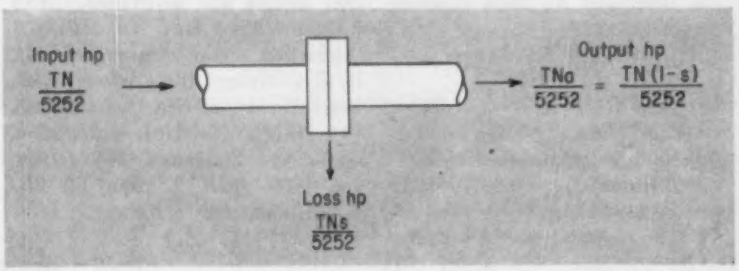
At standstill and full voltage the line current of a wound-rotor motor with short-circuited rings may be as high as for a cage motor—five to seven times full-load stator current. If external resistance is connected across the slip rings instead of short circuiting them, overall motor impedance increases and stator line current becomes smaller. Thus, the higher the external resistance the lower is the stator line current. For extremely high rotor resistance at standstill the slip rings are essentially open circuited, and stator line current is very closely equal to idle or no-load running stator current.

For a given load torque, say 100% as in curves shown, point *A* may represent a condition of slip rings short circuited. With resistance connected across the slip rings the motor may again develop 100% torque at a lower speed, such as at point *B* on curve *I*. Stator and rotor current at point *B* are the same as at point *A*. Adding increasingly more resistance across the slip rings lets motor develop 100% torque at successively lower speeds—points *C*, *D* and *E*. For each case stator and rotor currents have the same values as at point *A*. So when resistance across the slip rings is adjusted to provide 100% torque at any speed down to standstill, stator and rotor currents do not change in magnitude.

In applying wound-rotor motors you can make a useful approxima-



MOTOR-TORQUE CURVES show behavior of motor at different values of external rotor resistance. Stator, rotor current are constant at 100% torque value of *A*, *B*, *C* and *D*



ROTOR LOSS can be explained by analogy to slip coupling or slipping friction clutch. Major power loss resulting from slip is dissipated as heat produced in external resistor

tion: portion of the torque curves between synchronous speed and 100%-torque speed is a straight line. Note also that the breakdown (maximum) torque does not change with changes in rotor resistance.

Nameplates provide secondary or rotor data, such as *secondary voltage* and *secondary amperes at full load*. Secondary voltage is the open-circuit voltage measured between any two slip rings with rotor at standstill and rated voltage applied to stator terminals. Secondary amperes at full load is full-load rotor current, slip rings short circuited.

For example, we may use nameplate data to determine R_4 of curve *4*. R_4 represents total resistance in ohms, terminal to neutral, in the rotor circuit. It may be ten or more times the rotor-winding reactance at standstill, so locked impedance of the rotor may be assumed to be resistance R_4. To develop 100% locked-rotor torque at standstill, rotor current through resistance R_4 is approximately equal to nameplate secondary amperes at full load, produced by nameplate secondary volts. For 3-phase rotors:

$$R_4 = \frac{\text{sec volts}}{\sqrt{3} \times \text{sec amp at full load}} \quad (1)$$

Slip loss in the rotor of an induction motor can be determined from a mechanical analogy of the slip coupling or friction clutch, sketch. Input power to the clutch is:

$$\text{Input hp} = \frac{TN}{5252} \quad (2)$$

where

hp = horsepower
T = torque in lb-ft
N = Synchronous speed, rpm, of left-hand member in sketch

$$\text{Output hp} = \frac{TN_o}{5252} = \frac{TN\,(1-s)}{5252} \quad (3)$$

where

N_o = rpm of driven or right-hand member
s = slip, difference in rpm between rotating members divided by N, synchronous speed of driving member

Slip loss is the difference between input and output, so subtracting equation (2) from equation (1) gives

$$\text{Slip-loss hp} = \frac{TNs}{5252} \quad (4)$$

Equation (4) expresses in horsepower the slip loss at faces of the friction clutch. Same formula expresses loss in a rotor-winding circuit when the rotor slips in the synchronously rotating stator magnetic field of the machine.

Rotor loss at any speed may be calculated by means of equation (4). For a 3-phase rotor the loss may also be expressed as $3\,I^2R$ where I is rotor current, amperes, and R is total rotor circuit resistance, ohms terminal-to-neutral. Using equation (4):

$$\frac{3\,I^2R}{1000} = \frac{TNs}{5252} \times 0.746, \text{ or}$$

$$R = \frac{TN}{21.12\,I^2} \times s \quad (5)$$

If R_4, rotor resistance needed to obtain 100% torque at standstill, is calculated from equation (5) it should about agree with value obtained from (1). Let's illustrate the usefulness of (5): Assume that you need to develop 100% torque at a particular speed between standstill and full-motor speed. For constant torque at any speed rotor amperes are constant; therefore all quantities bracketed in (5) are constant, and rotor resistance is proportional to slip. Having determined R_4 from (1) you can calculate rotor resistance at any other speed:

$$R = sR_4 \quad (6)$$

Thus at 70% speed, slip is 0.30;

R_2 for 100% torque at 70% speed is 0.30 R_4. The calculated point for 100% torque is shown at point *c* at 70% speed. Value of R from (6) includes both winding and external resistance. External resistance is the difference between calculated value of R and the rotor-winding resistance.

Rotor-winding resistance may be measured by direct current or bridge methods between any two slip rings with the brushes raised. The ohmic value measured divided by two gives resistance per phase.

External resistance may be determined for any load and speed. Torque curve of a fan driven by a wound-rotor motor may be drawn with usual assumption that fan torque varies as the square of the speed. Example: Fan operation is desired at 80% speed. Since full speed is 98% of synchronous, required torque is $(80/98)^2 \times 100$ or 66.6% of full-load torque as shown at point *c*.

Compute external resistance:

(a) Draw a straight line from 100% speed, 0% torque, through 80% speed at point *c* of the fan curve and extend to point *C* at 100% torque. The straight line is a portion of the motor-speed-torque curve having rotor resistance of value R_2.

(b) Slip at point *C*, 100% torque, is 0.30. From equation (6), R_2 is 0.30 R_4 where R_4 has been obtained by utilization of equation (1).

(c) R_2 represents the total rotor resistance. Value of external rotor resistance may be obtained by subtracting the rotor winding resistance from the calculated value R_2.

Computation for a particular speed of load operation may be illustrated by a 300-hp 3-phase 60-cycle 720-rpm (synchronous) wound-rotor induction motor. Design constants of the motor were available to check by equivalent-circuit computation. From nameplate data, secondary volts were 690, secondary amperes at full load, 210. The rotor ring-to-neutral resistance was 0.033 ohms, taking one-half test measurement made between slip rings. Motor drives a fan having the fan-torque curve shown on p 233. You want to operate the fan at 80% speed and 66.6% of full-load torque.

(a) Draw a straight line from 100% speed, 0% torque, through point *c* at 80% speed, continued to point *C* at 100% torque. The slip *s* at 100% torque is 0.30. From (6) calculate required resistance (all ohmic values are terminal-to-neutral) in the rotor circuit:

$R_2 = sR_4 = 0.30$ ohms

(b) Determine R_4 from equation (1):

$$R_4 = \frac{690}{\sqrt{3} \times 210} = 1.89 \text{ ohms}$$

(c) Then $R_2 = 0.30 \times 1.89 = 0.567$ ohms

(d) Rotor external resistance is:

R (external) $= 0.567 - 0.033 = 0.534$ ohms

To determine thermal capacity of the resistors assume rotor current is proportional to torque. Rotor current for 66.6% torque may be taken as 66.6% of 210 amperes, which figures out to 140 amperes.

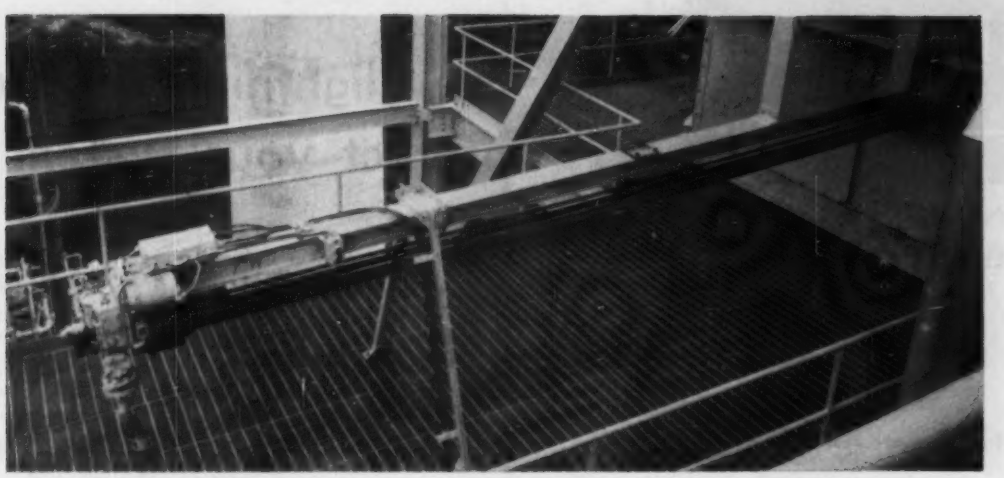
Short method of determining external rotor resistance for speed-regulating wound-rotor induction motors requires that you make some approximations. You must ignore slip-ring-brush voltage drops, assume that torque curves from no load to full load are straight lines, rotor reactance is small compared to resistance, etc. Although satisfactory for many applications, method can't be used for torques much greater than 100% because speed-torque curve may deviate considerably from a straight line.

If you want to look more deeply into these subjects, the following references will be helpful: (1) *The nature of polyphase induction machines*, a book by Philip L Alger, published by John Wiley and Sons, Inc, New York, N. Y. (2) "American standard test code for polyphase induction motors and generators," *ASA C50.20—1954* (*AIEE No. 500*) (3) "Induction motor torques defined," by R C Moore, *Allis-Chalmers Electrical Review*, Second Quarter 1958. (4) NEMA Standards publication, motor and generators, *MG 1-1959*, Jan 1959 (part 2, page 14, *MG 1-2.16*, nameplate marking).

Photography facilitates power-equipment handling

By mailing photographs of outgoing shipments a manufacturer can alert the purchaser. Since installation sites for power equipment are rarely next to railroad sidings, photographs tell the purchaser what he may need in the way of cranes, lowboys or other special handling apparatus.

For two years S&C Electric Co, Chicago, have been photographing shipments of their large switchgear. The practice was started to study shipping methods; photos were taken at their plant and at purchaser's plant when shipment was received. Technique has many benefits: improved blocking reduces damage, shipping personnel are better trained, shipping is expedited because railroad inspectors indicate preliminary acceptance based on photos of prior shipments.



TWO-SPEED DRIVE modification doubles retractable lance's traversing speed, holds rotational speed constant

Cut time cycle 25%, save on air or steam with this . . .

New method in soot blowing

By BERNARD K KELLY, Senior Engineer, Long Island Lighting Co

Central-station steam-generator capacity has increased so rapidly in recent years that sheer physical size of today's units brings up new soot-blowing problems.

As the units get larger they need more soot blowers. These, in turn, call for more blowing medium—air or steam. Both add up to greater time consumption in completing a full boiler-blowing cycle. Problem: How to get needed blowing-medium capacity when (1) as so frequently happens, a second blowing cycle must be started before the first one is completed or (2) a second unit must be supplied from a common blowing source?

Problem took on serious proportions when No. 3 unit for our Port Jefferson station was in the planning stage. This unit is one of several in which we use air for soot blowing and we had to know how we stood.

We went over the potential difficulty with our soot-blower manufacturer, Copes-Vulcan Div of Blaw-Knox Co. Result was a relatively simple solution and one which reduced the blowing cycle by three hours with a considerable saving in operating cost.

Answer was a slight modification in the retractable soot blowers themselves: replacing each blower's single-speed lance-traversing motor with a 2-speed unit. The Copes-Vulcan design made this possible because it uses a 2-motor drive. One motor rotates the lance, the other extends and retracts it.

As now installed on No. 3 unit, each retractable soot-blower lance advances into the furnace pass at twice its standard speed. There is no increase in rotational speed, which might make the nozzle end whip or reduce cleaning efficiency, because lance continues to be separately rotated. High-speed feature can be applied to either extension or retraction phase. A "fast out" gives further protection on emergency retraction.

New traversing speed saves 25% in total cleaning time, thus a 25% cut in blowing medium needed. Put another way, our 1.15-million lb per hr steam generator has shrunk so far as soot-blowing requirements are concerned. And cut in cleaning time and air needed saves an appreciable amount of compressor operating time.

There has been no cleaning-performance drop at new speed. Heavy deposits are dislodged at the higher extending speed with final finishing touches added to the cleaning job during standard-speed retraction. There was no need for added controls or manipulating devices which might complicate soot-blowing procedure. Blowers come into action as they do with standard-speed motor drive.

All in all, results are so encouraging that a similar setup will be used on No. 4 unit, currently going up at Port Jefferson. After this experience with the modified blowers, we anticipate a possible reduction in size or number of air compressors and receivers needed with future installations.

Saving in blowing cycle we've experienced at Port Jefferson is representative of what can be done through careful study of soot-blowing economics. Although modification of our soot blowers involved a system using air as the blowing medium, it should work equally well with a system that uses revenue-producing steam.

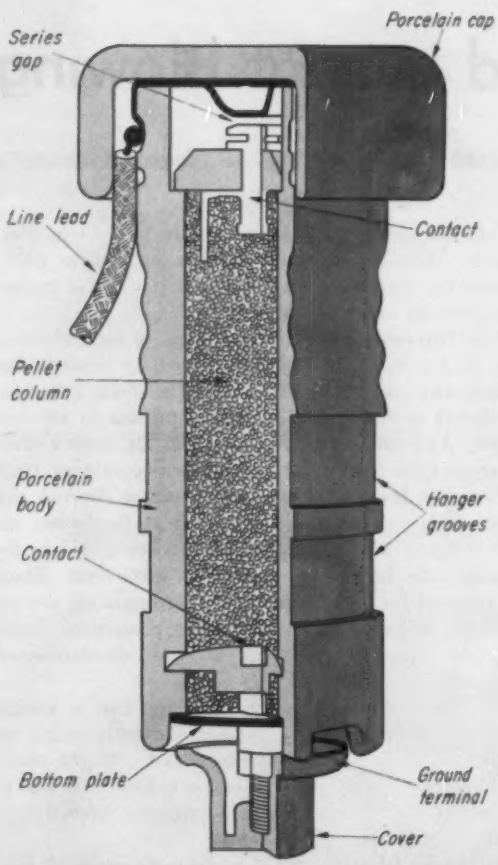
Plant Electrical Fact File

NO. 45:
LIGHTNING ARRESTERS

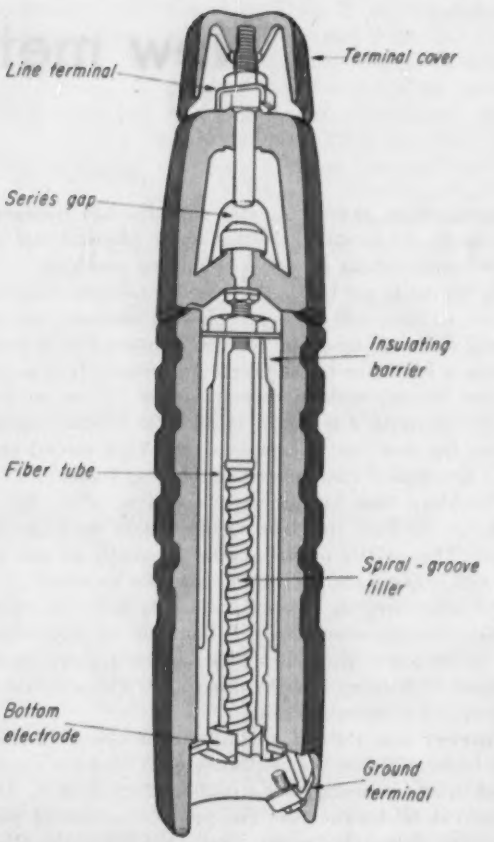
How lightning arresters protect your system

By NORMAN PEACH, Associate Editor

High-voltage surges on an incoming power line can be caused by lightning, major faults or switching large blocks of power. Lightning arresters protect distribution systems by shunting the surges to ground. Basic principle: present a high impedance to operating voltages, but a low impedance to the high surge voltages. Many types of arresters are in use; three widely used modern types are shown here. Arresters are designated as *station* class and *line* class. Station units have higher discharge capacity.

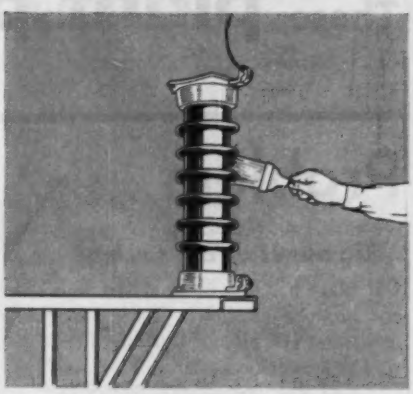


PELLET types have column of lead-peroxide pellets, varnished for insulation. Surge voltage breaks down varnish. After surge discharges, lead peroxide reacts to heal punctures in pellet insulation and restore initial condition. They're widely used for circuits up to 15 kilovolts

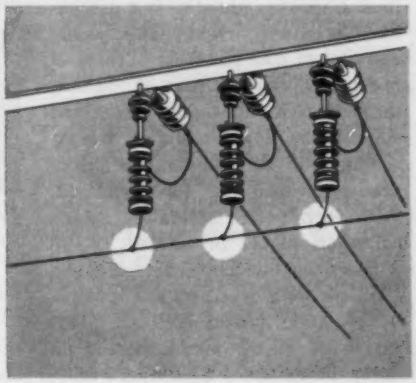


EXPULSION principle is used in these medium-voltage arresters. Initial spark path is across gap, then straight down wall of fiber tube. As the arc increases, the gases generated force it through the spiral groove, stretching it out and limiting circuit current which flows to ground

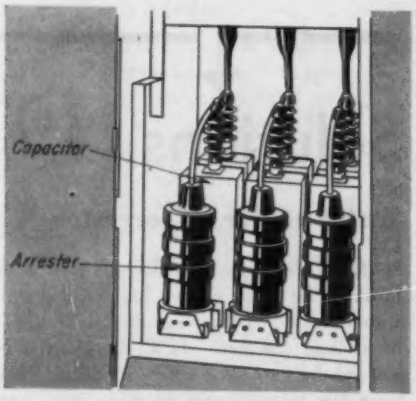
Lightning-arrester tips



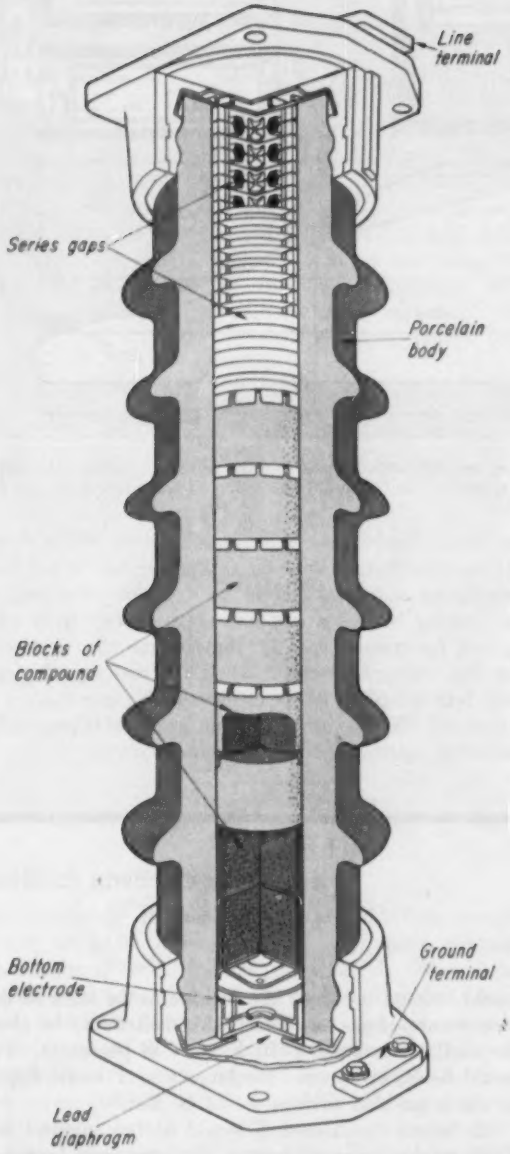
CLEAN arresters same as insulators. In some areas coating arrester with silicone grease reduces frequency of cleaning. In other areas use high-pressure washing



GROUND connections must be kept tight and ground resistance low. Conductors, ground rods, etc must have adequate capacity to carry discharge current to ground



ROTATING MACHINERY can be protected from voltage surges by arresters and capacitors designed for this and coordinated with your regular substation arresters



DISKS of special compound are used in modern heavy-duty lightning arresters. They readily pass surge current, but limit the ground current which flows from system when arrester conducts. Series gaps keep arrester nonconducting until voltage rises to predetermined value

These **plant problems** could well be yours...

Problem...

Big boner or big saving?

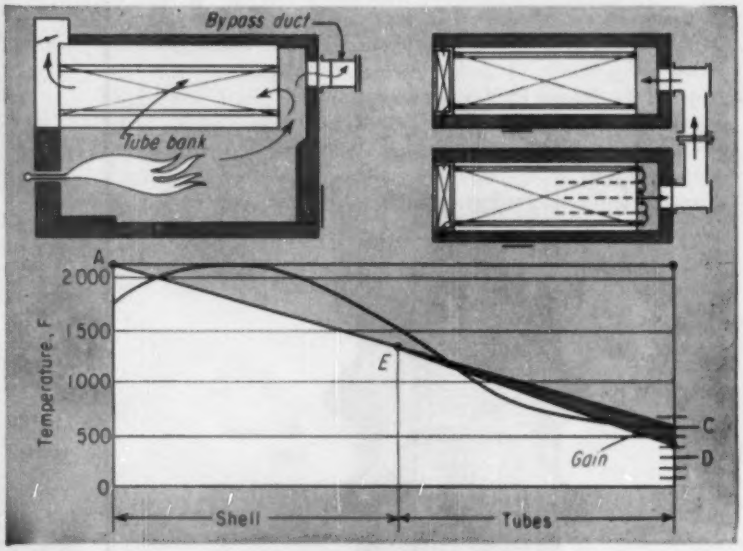
Our plant has two oil-fired Hrt boilers, grouped as shown. Each boiler is rated at 100 hp and 100 psig. Pressure is kept between 70 and 90 psig. Full-load flue temperature is 600 F.

During the daytime we fire boiler No. 2 at 4000 to 8000 lb per hr, and during the night boiler No. 1 carries 2000 to 4000 lb per hr. Because of corrosion problems with intermittent load, I have suggested we install a gas duct as shown, right. This would allow us to split gas from burners of one boiler, running part of the flow through each tube bank. We could control gas flow by outlet damper settings and the comparative steam-production readings for each unit. With each boiler generating steam, corrosion should be limited.

Based on the following reasoning, I believe we may expect a 5% cut in our $40,000 annual fuel bill. This saving of $2000 would more than cover the estimated $200 duct cost.

I arrived at this figure by drawing the diagram, above. For simplicity I disregarded heating area of back tube sheet. Estimated temperature vs gas travel is plotted for present full load and for split gas flow. Shaded area represents heat transferred to water. Small wedge represents added absorption due to gas' having twice the time and heating area for transfer. We estimate new flue temperature will come halfway between 600 F and boiler temperature of 300 F, or about 450 F. Absorption equates to about a 5% boost, which should show up as 5% less fuel at full load.

Before we try this idea out, we would like some answers from readers: 1) Has anyone tried a similar setup? 2) Is the reasoning logical? 3) Is estimated 5% saving close to what we can reasonably expect?—*AVW, December* POWER



BYPASS DUCT connecting two Hrt units permits splitting gas flow between tube banks. Fuel saving is expected to result from increased absorption at lower tube-bank gas flow

Solutions...

Watch out for h-t corrosion

If *AVW* wants to split flue-gas flow from one furnace through the tubes of two boilers he'll have to control it automatically. Otherwise flow will not divide equally when load changes. *AVW* mentions a corrosion problem but does not state where it occurs. If corrosion comes from low temperatures resulting from operating the two boilers at reduced output, he'll have to check for increased corrosion when he operates both tube banks at reduced temperatures. We have found corrosion with metal temperatures as high as 350 F. In any case a vent would be required from idle furnace to the stack so that temperature of gas in contact with shell would be above the shell temperature (316 F at 70-lb pressure). This would be tricky to size: too large a vent would bypass so much gas that savings would be lost.

All factors considered, I would not recommend that *AVW* try his proposed bypass. Danger from increased corrosion is too great and the proposed 5% saving probably would not be realized unless conditions were perfect at all times. Perhaps *AVW* could boost efficiency by better combustion control, air preheater or economizer.

A A SMITH, *Quebec, Canada*

...Here's how *Power* readers would tackle them

LAWSON STEWART, Associate Editor

Change firing methods

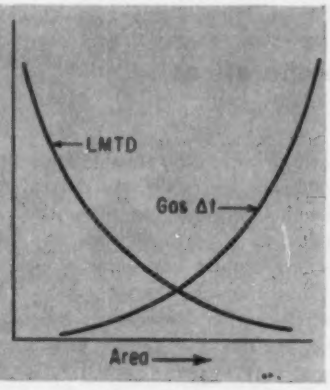
At firing rates of 4000 to 8000 lb per hr *AVW* should not experience problems with corrosion if boiler No. 2 is secured with dampers closed when No. 1 is put on-line at night. Furnace will retain considerable heat for this period of downtime.

A fuel saving during daytime could result from base loading No. 1 at minimum load (about 4111 lb) and swinging load on No. 2. It is doubtful that maximum efficiency results from a firing rate of 8000 lb on a 100-hp Hrt. Peak efficiency probably occurs nearer 7000 lb.

If sufficient heat is not retained in No. 2 by proper securing as suggested above, try base loading minimum load (of approximately 2000 lb) on No. 1 and swinging balance of load to No. 2. These two suggestions will probably save *AVW* 5% with no added expense.

W H KEITH, *Albany, Ga.*

% S in fuel	Metal temperature, F
0	180
1	180
2	185
3	220
4	224
5	258
6	270



Recheck absorption figures

It is questionable that the shutdown period is long enough to cool the gases below dew point. Frequently, thermal capacitance of boiler-furnace refractory is sufficient to maintain gas temperature above its dew point for a long time. But ducts, breeching, i-d fans and unlined steel stacks are prone to corrosion, since the surfaces of these components are usually exposed directly to the combustion gases and are not covered with refractory having heat storage. For these conditions, it may be necessary to bypass gas into these areas only. Table, above left, shows recommended minimum metal temperature as a function of fuel-oil sulfur content.

Assuming the furnace temperature is too low, idea described by *AVW* may be employed. It is similar to that sometimes used for controlling corrosion in boiler-air preheaters. When operating at light loads, gas temperatures are low. Air heaters are subject to corrosion resulting from dew-point approach of combustion gases containing moisture and sulfur. One means of limiting this problem is to recirculate hot air from the air-heater outlet back to the inlet. This keeps metal temperature at the cold end above the dew point of the gas.

AVW estimates the gas temperature will drop to 450 F, but does not indicate how this value was determined. My graph is a representative plot of combustion-gas temperature drop and LMTD (logarithmic mean temperature difference) as functions of heat-absorption area. Curves show that temperature drop increases and LMTD decreases with heat-transfer area. It is necessary to know these relations for the existing boilers to determine if sufficient temperature differences are available throughout the gas circuits to generate required steam quantities and pressures. Check relations at full and half load.

Although heat-transfer area may be doubled, complete utilization may not be realized because of temperature limits. Knowing what effective heat-absorption area he has, *AVW* can estimate potential fuel savings of his proposed design. He also needs more-realistic duct cost.

Since calculations of this type are complex, requiring the services of personnel experienced in convective and radiant heat transfer, I suggest *AVW* discuss the subject with the boiler manufacturer.

H B WAYNE, *Woodhaven, N. Y.*

Editor's corner

There are two other factors in *AVW's* solution which should not be overlooked. Since temperature of bypassed gas may approach 2000 F *AVW* must construct his duct with a refractory lining using either insulating firebrick or castable good for 2000 F. He must include an isolating damper, preferably alloy-steel sliding plate, and put a lot of thought into selecting one either free from heat warpage or designed to compensate for warpage.

As a second point, *AVW* must control gas flow by dampers. Even if boiler outlet dampers are adequate for control applications, extra throttling required to balance flow boosts draft loss and may overload f-d fan at some steaming rates. For safety's sake, *AVW* should have an extra 1-in. H_2O up his sleeve.

More **plant problems**

Problem...

What is the best kind of wiring for our plant?

We plan to renew electrical wiring in older plants fabricating moderate-sized metal parts. Processes include stamping, machining, degreasing, plating. We will use 4160 v for primary distribution and large motors, 460 v for smaller motors, 460/265 v for fluorescent lighting.

We are considering insulated aluminum aerial cable for 4160-v lines, aluminum bus duct and copper cable in troughs for lower voltages. How will this system work out? How did readers avoid corrosion problems with aluminum and copper junctions? Does system involve new maintenance procedures that will boost costs?—*JME, December* POWER

Solutions... Use special joint preparations

Aluminum for 4160-v conductors and aluminum and copper cable for the lower-voltage circuits have been used successfully. When properly designed and installed these materials require minimum maintenance, providing continuity of service in areas subject to varying ambient conditions. Maintenance methods are conventional.

Advantages of aluminum conductors and bus bars are well known. These include light weight, high resistance to corrosion and generally lower price. In addition, a large selection of shapes provides optimum design of bus bars for any combination of plant conditions.

Aluminum conductors have high corrosion resistance under many conditions. This results from the thin film of aluminum oxide that forms when they're exposed to the atmosphere. Where severe exposure prevails, a thicker film will develop. Films frequently cause "self-stopping" corrosion before a severe condition occurs.

Current-carrying capacity of enclosed aluminum buses (as of other bus) is influenced by enclosure materials. Conductor rating in a nonmagnetic housing is approximately 75% of the indoor current rating. For high-current service and when bus is in close proximity to the enclosure walls, nonmagnetic housings are recommended by most manufacturers and consultants.

Approximate relationship of current-carrying capacity for magnetic and nonmagnetic enclosures is: *Rating of magnetic enclosure* = 0.85 × *Rating of nonmagnetic enclosure*. Exact value depends upon distance between conductor and walls and current magnitude. A rule of thumb limits bus bar ac to 1200 amp when bus is installed in a magnetic housing. Higher current ratings usually require nonmagnetic enclosures.

New aluminum surfaces have a low emissivity, which increases after atmospheric exposure. Painting alumium bus bar increases radiant heat loss. A flat, nonmetallic paint may increase current rating by 25%.

Coefficient of expansion for aluminum is about twice that of steel and one-third greater than for copper. So movement must be limited to prevent high stresses to conductors and connected equipment.

On long conductor runs having rigid tap-offs to equipment, flexible couplings between bus sections, sliding bus supports and flexible tap connections are frequently used to provide free movement.

Aluminum-joint preparation requires removal of protective film and complete filling of joint with special sealing paste. Where aluminum and copper bus bars are in contact, joint preparations should also be used. Usually, for indoor installations, galvanic corrosion is not a problem. However, outdoor installations may require covering the joint completely to exclude air and moisture. Molded plastic covers, tape and sprayed- or brushed-on paint and films are available for this service.

H B WAYNE, *Woodhaven, N. Y.*

Try ACSR cable

Using 4160 v for primary distribution and large motors is a very wise step. As a matter of fact, this system has become the most widespread and popular high-voltage system for inside distribution. It offers advantages of load-center primary distribution.

From past experience and studies we know 4160-v primary distribution and 480/277-v 3-phase 4-wire systems could very well apply to the proposed 460/265 volt system. This type of construction can result in savings of from $24 to $27 per kva equipment demand in comparison with conventional 208/120-v system.

In regard to the aluminum aerial cable, many factors have to be investigated. *JME* should consider use of ACSR cable, which is aluminum, steel re-enforced. Better yet, engage the engineering service of any of our large aluminum companies to help select the cable.

As to aluminum bus duct and copper cables, idea is excellent and no problem should be encountered. Fear of possible corrosion of aluminum to copper has been reduced by recent metallurgical developments. Today special plated or inhibitor-compound connectors for aluminum to copper provide long corrosion resistance.

C BACHMAN, *Jamaica, N. Y.*

Corrosion *can* be prevented

JME should have success with his proposed electrical-distribution system if it is installed by competent electricians familiar with the aluminum-handling procedures recommended by manufacturers. Apart from cost differential (usually the factor deciding in favor of aluminum) there may be a weight advantage in using aluminum. At 600 v and below, the weight advantage can be important. But if *JME* is considering weight advantage of aerial cable at 4160 v, he'd better compare total weight per ft of assembled aluminum and copper cable. Aluminum will weigh less, but weight of conductor doesn't influence total weight as much in h-v as l-v cables since insulation must be heavier.

In ordinary fairly dry locations copper-to-aluminum junctions should cause no trouble if simple installation recommendations are followed. In corrosive atmospheres, such as plating rooms, extra care at installation is in order. There are special greases or paints for junctions in this type of location. Frequent inspection of electrical apparatus in corrosive atmospheres is necessary whether or not aluminum is used, and I don't see that aluminum-copper combinations impose extra maintenance. Failure to protect aluminum-copper junctions properly, however, can lead to disastrous galvanic corrosion.

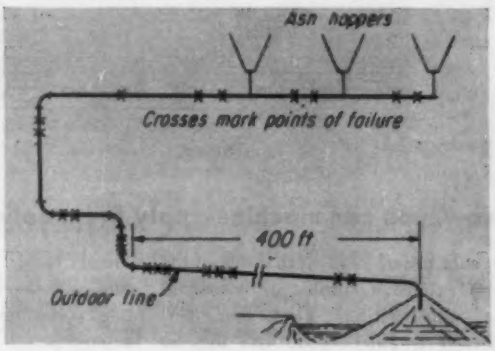
E WAGNER, *Minneapolis, Minn.*

Your March problems

What size work crew?

We would like to know if anyone among POWER's readers has ever studied relative costs of a maintenance crew of sufficient size to do all required maintenance in a 5-day week versus a smaller crew working six days without production on the sixth day.

We do not have records to conduct such a study ourselves and hope other readers may be able to help us out.—*CAB*



How can we stop ash-line wastage?

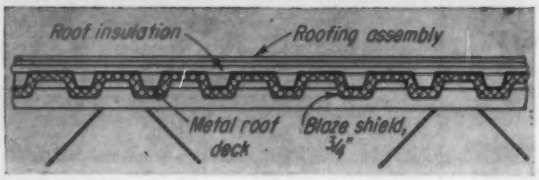
Our plant operates four pulverized-coal-fired boilers rated at 80 mlb per hr of 600-psig 750-F steam. For normal plant loads we fire all four units at about 75% of full load. Aside from a slight drop in load during July and August we maintain fairly continuous 240-mlb-per-hr total load. All four units include flyash hoppers discharging into a hydraulic ash line and on to a settling basin. Ash line is 10-in. extra-heavy cast-iron pipe with flanged joints. Ash has high sulfur content.

Our biggest plant problem is ash-line wastage. Pipe sections and bends often fail after six months' service. Cause seems to be combined corrosion and erosion. Wastage occurs on bottom of horizontal runs and following bends (shown in drawing).

We would like to hear from POWER readers who have licked this type of maintenance headache.—*SDA*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches

Timely **practical ideas** to help solve



Now, you can machine-apply fireproofing to metal roofs

Livonia fire of 1953 started one of the most extensive studies of industrial roof construction. That year, GM suffered a $35,000,000 fire loss at their Livonia, Michigan plant. Studies revealed that a major factor was molten asphalt dripping from the roof, through the side joints of a ribbed-metal roof deck, to the occupied floor area. Witnesses said fire along underside of roof deck was often more than 100-ft ahead of fire on the floor. Burning asphalt from the roof carried fire to combustible surfaces within the plant.

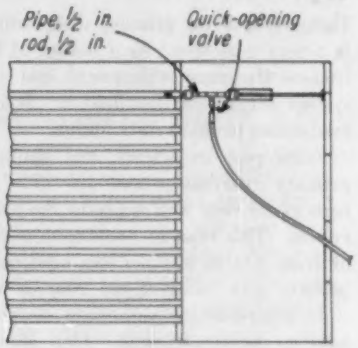
Roof assembly over the Livonia metal deck was made of alternating plies of 25-lb solid mopped asphalt and 15-lb roofing felts as a vapor barrier. Vegetable- and glass-fiber insulation board was mopped in place over the vapor barrier; a built-up roofing assembly was mopped to the insulation board. This type of assembly was rated as incombustible. Since that fire, of course, insurance factors have reclassified similar roof construction to a combustible rating.

In 1955, following tests made with Metal Roof Deck Technical Institute and the Insulation Board Institute, some insurance firms placed insulated-metal deck construction in two categories, Class I and II. Class I was limited to systems having a low degree of combustibility. Any insulated-metal roof deck not meeting the requirements of Class I was considered Class II.

Preferred-risk firms were faced with modifying their roofs to meet Class I requirements or installing automatic-sprinkler systems.

A series of tests resulted in the acceptance of a new system for modifying Class II construction, which has many of the benefits of Class I. A blaze shield, applied to the underside of Class II roof decks, can result in reclassification. Then you can omit automatic sprinklers in buildings of noncombustible occupancy.

This blaze shield is a blend of inorganic mineral fibers and binders, forming a low-density blanket or coating to cover the roof deck. It is marketed by Columbia Acoustics and Fireproofing Co, Stanhope, N. J.



Look ma, no hands

Sketch shows a gun we developed for shooting condenser tubes. I've seen many guns for shooting plugs through tubes, but the plugs we used needed 125-psi water pressure. We couldn't hold guns against this pressure all day, so we decided to let the water pressure do the holding for us.

Cylinder consists of brass tubing 8-in. long with an ID of 1 3/16 in. Piston is a metal disk with a leather cup attached. To operate we press the rubber tip on gun's end against tube end containing the plug. Press the handle on the quick-opening valve and water enters the gun and exerts piston pressure both ways in it. Since piston area is greater than the area of condenser tube, gun's end is pressed against tube end with enough force to prevent leakage. When plug is driven out of tube and the valve is closed, piston is drawn back enough to allow gun to move to next tube.

Operator just holds up the gun and presses the valve handle. Water pressure does all the hard work.

E W McKnight, *Chapel Hill, N. C.*

We all make mistakes

Years ago our old chief said, "We can make a coal calorimeter." This sounded pretty good so we went to work. The chief was a gruff individual from the old school and we tried to

your tricky design and maintenance problems

STEVE ELONKA, Associate Editor

please him. That was good business in those days—still is, I'm told.

After a lot of experimenting, reading, working holidays, Sundays etc we constructed a peroxide calorimeter. But we needed some laboratory equipment which included a thermometer for the instrument. Searching our catalogs, we found a standard calorimeter thermometer graduated to 1/100 F. This was priced at $18.75, which was a lot of money during the depression when times were tough.

We finally sold the chief on the thermometer so he ordered one. But he griped, "I don't know why I buy this. You'll just bust it anyway." I promised him I'd guard it with my life. This I did for about a year. Then one Sunday I was in a hurry to finish up and go pheasant hunting. Crash—I broke the thermometer.

To say I spent a few bad hours is putting it mildly. I'd have bought one with my own money if I could have borrowed, begged or stolen enough to do it.

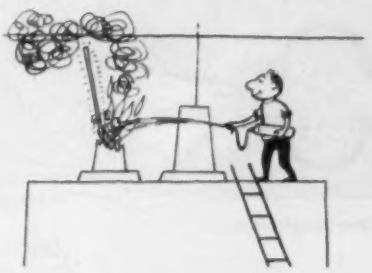
I couldn't think of any way to get out of telling the chief I'd broken the thermometer. Worse yet, I didn't know how to tell him so he'd not say "I told you so" or use the large-size flame on me. Needless to say, I left the pheasants alone, and that night I rolled and tossed until three am before I had the answer.

At eight the next morning I walked into his office, quavering in my boots. I could hardly stand, let alone talk. He roared, "What did you do now?" That almost floored me. But I managed to squeak out, "Well, I fell like you did when you broke that battery six months ago."

Another roar, "What did you break?" I answered, "That thermometer you bought for us."

He looked me in the eye for a full minute, then said, "Well . . . I'll be damned," and let out a roar of laughter. Then he ordered another thermometer. Boy, did I breathe a sigh of relief as I tiptoed out.

K M WHITE, *Chamois, Mo.*



What would you have done?

Years ago in a new public utility station the bushing on the high side of an 11/104-kv power transformer blew up and caught fire. The circuit breakers on both sides opened and isolated the bank.

Each transformer was installed in a concrete cell, with a wall on three sides, under the floor of the building's second story. The bushing was made of an asbestos composition and filled with an oily compound. EDITOR'S NOTE: *Transformers were installed in 1909.*

I got a ladder, climbed on top of the transformer tank and started playing carbon-tet on the fire. Part of the bushing had been blown away, exposing the compound inside of the bushing. The CCl_4 gas would extinguish the blaze where I played it on the fire, but the fire kept burning on the opposite side as I followed it around.

Smoke and CCl_4 fumes were making me feel faint. Then I saw that the rod down through the bushing was red hot, and that it was vaporizing the compound inside the bushing and keeping the fire going. I could see that I was never going to win this way.

I yelled for the operator to pass up one of the soda-acid extinguishers. He objected, but I told him carbon-tet guns were having no effect and that if we didn't get that fire out quickly, it would ignite the fumes from the transformer oil and then we'd have a real fire. Maybe we'd lose the station.

He handed me the soda-acid extinguisher and I played the stream down on the red-hot rod. Soon it was cool and I easily put the fire out.

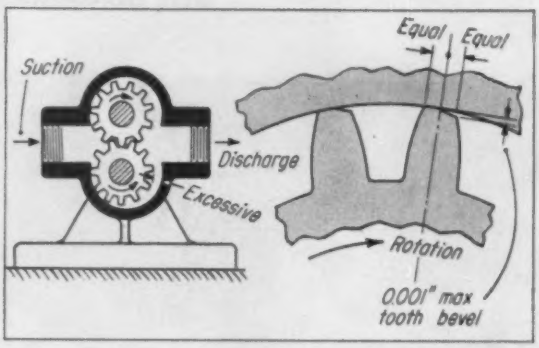
We got the super on the phone who, in turn, rounded up a crew and got them busy cutting out the damaged transformer and putting in a spare. I told the super how I had put out the fire. Also that I probably ruined the oil in the transformer tank, but I felt that if the oil had ignited it might have resulted in a fire that could have burned down the entire station. He agreed that I was right in putting out the fire as quickly as possible. What would *you* have done?

H T LIVINGSTON, *Los Angeles, Calif.*

Did you know . . .

that of 3488 electric-motor-winding failures examined by Hartford Steam Boiler and Insurance Co, 524 were caused by moisture, 425 by insulation deterioration, 341 by line surges, 193 by dirt and grease, 160 by overloading, 75 by protective-device failures? How are *your* motors? Better check 'em.

More **practical ideas**



Our gear pumps last longer and give us less trouble

Bearing wear resulting from discharge pressure acting on gears of our gear pumps caused the periphery of these gears to come into metal-to-metal contact with the housing. That wore the housing and the top of the teeth. Result was loss of efficiency and pump deterioration.

To minimize this trouble with new pumps we now grind a very small bevel along top of driver and idler teeth as shown. Fluid pumped is not scraped off the housing while pump is running as with the original teeth. Instead, fluid films are generated between top of teeth and housing. That separates gears from housing and prevents metal-to-metal contact.

Pressure development in these fluid films tends to counteract bearing loads due to tooth contact and hydraulic pressures. That reduces bearing wear and prolongs pump life.

E WITTMANN, *Villas, N. J.*

Just play the averages

My first three days on the graveyard shift as a refrigeration engineer in a packing house were the toughest I can remember. I checked and rechecked the various rooms and products. All seemed well. But the head butcher told me on the third morning, "If those hogs are frozen tomorrow the way they have been the last three days, I'll put *you* on the meat block." And he looked at me as if he meant it.

Hogs were to be at 35 to 38 F at eight am. When I made my final round at seven, hogs were always at 36 to 38 F according to the thermometer stuck in one of them. That thermometer was secured to the wall by a chain. I would shut the refrigeration unit down then, assuming hogs would get warmer, but they froze instead. I knew that if they were frozen again I'd be leaving. I felt bad and discussed my plight with a farmer at the stockyards that evening.

"Heck, sonnie," he said, "you're an engineer. Ya ain't supposed to know everything. I'll help ya." He explained that some hogs are grain fed, some peanut fed. "Makes a difference, ya know." So he brought me four thermometers next shift. He and I stuck the five thermometers in different hogs, spaced around the room. That gave me a variety of temperatures, but by averaging them I knew to shut down at five am and no hogs froze.—T MULLIN, *Seattle, Wash.*

My biggest boner

The sand dredge I signed on a few years ago had the most run-down engine room I ever sailed in. All the pumps handling sea water were naturally hard to keep in shape because of the grit. Their liners, plungers, packing and rods got scored after only a few months' service. All the stuffing boxes leaked so badly that bilgewater was usually up to the floor plates and then sloshing around.

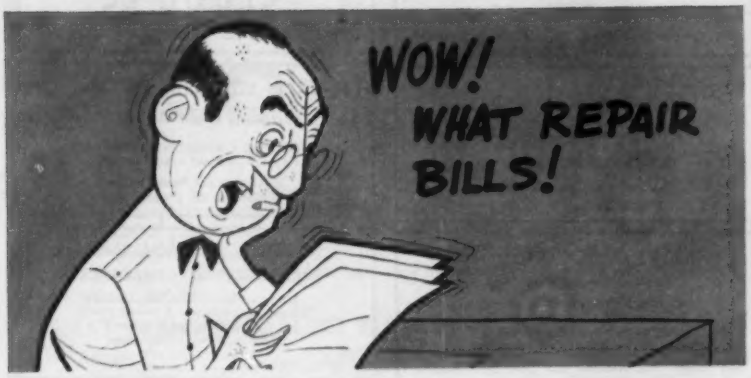
On my first watch, the large reciprocating fire pump was running at top speed, trying to keep the bilge down. But it just barely held its own. Tightening the pump glands to keep more water from leaking into the engine room didn't help. Piston rods on the steam duplex bilge pump were so badly scored that it looked as if all the water it pumped was leaking out of its stuffing boxes.

I tore the bilge pump apart and made two new piston rods in the lathe. But when I had that pump adrift, with parts all over the floor plates, the bilgewater started gaining on us. I worked at white heat trying to get the pump back together. I had made the rods before taking the pump adrift, but found that one rod was ¼-in. oversize. My new rod wouldn't fit. And water kept on rising.

On most ships you can close the sea suction to the main circulator and open the bilge suction. That pumps bilgewater through your condenser, to maintain the vacuum and also keep bilges dry. But our circulator wouldn't lift water from that depth so we couldn't try that.

By the time I had the bilge pump together the floor plates were floating. The skipper was ready to beach the ship—and me. Since then I make sure of my measurements and have all parts ready before taking anything adrift while the ship's at sea.

R R BRUBER, *Wharton, N. M.*



Does your plant have these headaches?

By C T BAKER, Atlanta, Ga.

A new ice-cream and dairy plant had three ammonia compressors. One handled the ice-cream-hardening room, others cold storage and milk storage at 35 to 36 F.

For several months after startup everything worked fine. But the following year they couldn't hold the temperatures, even with two compressors working together. Before, one unit handled the load easily.

Here's what I found wrong: (1) Ammonia system was loaded with air, sending condensing pressures way up. (2) Only a small hand purge was provided for purging the foul gases. (3) Fan-driven cooling units of each room were not fitted with oil-drain valves for drawing oil carryover from the coils. Lone exception was a float expansion valve. Other units were the ceiling-suspension type, fitted with thermal expansion valves. (4) Both milk and chocolate mix were cooled by a tubular cooler, using water and direct-expansion ammonia as cooling mediums. Liquid ammonia was supplied to ammonia section of cooler by an automatic float feed valve inside a surge drum.

In spite of this modern, efficient method of cooling, temperature of fluid seldom got below 65 F. Oil, pipe scale and other foreign matter had accumulated in the surge drum. They interfered with float expansion valve's operation until it couldn't work properly. Here again, there was no way to drain oil.

(5) Large quantities of oil were pumped from the crankcase of a compressor and reached the cooling-unit coils through badly leaking piston rings. Only one unit had an oil drain, which was never used. Operators had to add a gallon of oil to the compressor every day. It didn't take much oil before the cooling coils were completely filled—coil space that should have been occupied by ammonia. That machine was really swamped, but even a little oil would have been bad, since it won't conduct heat.

(6) With three compressors in this plant, there was only one pressure gage to indicate condensing pressure. If this single gage went haywire there would be no way to know condensing pressure. And there was no high-pressure cutout to stop the compressors in case of over-pressure should condensing-water supply fail. Altogether, a potentially dangerous situation.

For an efficient, safe plant, I installed oil drains for all room-cooling units, and added one for the tubular milk cooler at the same time. An automatic purger made sure ammonia system could be maintained free of air. Then we solved the oil-pumping problem with a new set of piston rings and put in two high-pressure gages. Finally we opened the suction-pipeline strainers at each compressor for inspection and cleaning.

Now, the dairy plant goes like clockwork—as you can expect a well-designed plant to do. If your plant seems to be accident-prone or a repair-bill spendthrift, check for some of these faults. And if you find any, I suggest that you correct them as soon as you can!

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REDUCTION GEAR: S-115—form A—RPM 7964/3000.

TURBINE STEAM PRESSURE: 375 lbs—175°F superheat-exhaust pressure 1 lb. absolute when condensing. Can be used condensing or non-condensing.

BUILT AS MARINE UNITS USING FINEST MATERIALS. DRIP - PROOF CONSTRUCTION. UNITS ARE 16' LONG — 7'8½" WIDE. MOUNTED ON PRE-FAB SUB-BASE.

OPERATING CONDITIONS

1. The turbines are designed for normal operation condensing at 375 lb per sq in gauge, 175°F superheat steam at throttle, and 1 lb. per sq. in. absolute at the turbine exhaust flange
2. The turbines will operate successfully condensing at 375 lb. per sq. in gauge, 0°F superheat at throttle, and 1 lb. per sq. in. absolute back pressure at the turbine exhaust flange.
3. The units have an overload capacity of 25% (1250 KW, 0.80 p-f) for two hours with normal main and exhaust pressures.
4. The units have an overload capacity of 50% ((1500 KW, 0.06 p-f) for five minutes with normal main and exhaust pressures.
5. The units will deliver normal output (1000 KW, 0.80 p-f) with main pressure 20% below normal and with a back pressure of 2 lb. per sq. in. absolute at the turbine exhaust flange.
6. The turbines will operate successfully with a maximum main pressure at 450 lb. per sq. in. gauge and with a maximum superheat of 200°F at the throttle.
7. The turbines will develop 500 KW with 375 lb. per sq. in. gauge, 175°F superheat steam at throttle, and 29 lb. per sq. in. gauge back pressure at the turbine exhaust gauge.
8. The turbines will operate successfully when extracting steam from the second-stage shell of the turbine. An automatic pressure regulating valve and a non-return valve should be installed in the extraction line to hold the extraction steam at approximately 10 lb. gauge and to prevent a return flow of steam to the turbine.
9. The turbines will operate successfully with full steam flow to atmosphere.
10. The units will cover the entire range of conditions as listed above under automatic control of the speed governor.
11. The steam flow to the throttle is guaranteed not to exceed the amounts listed in Part V for the given loads when operating with steam at 375 lb per sq. in. gauge at throttle, 175°F superheat, and 1 lb. per sq. in. absolute at the turbine exhaust flange. The guaranteed steam flows include the necessary steam for sealing the packing glands, and includes the electrical losses for the exciter fields and rheostats.

THE BOSTON METALS CO.

313 E. Baltimore St. Baltimore 2, Md.

ELGIN 5-5050 LEXINGTON 9-1900

Circle 506 on Reader Service Card

CHECK WITH WAGNER FIRST!

Thousands of new and "Certified Rebuilt" Motors & Generators in stock—up to 1000 H.P.
OUR 54th YEAR

A. C. MOTORS—60 CYCLE

HP	Mfr.	Type	Volts	Speed
800	Whse. (2)	Sq. Cage	2300	1800
750	G.E.	Slipring	2300	514
700	Whse.	Slipring	2300/4000	1200
600	G.E.	Synch.	450	900
600	Elliott (2)	Sq. Cage	2300	900
500	Allis Ch.	Slipring	2300/440	600
400	G.E.	Sq. Cage	440	1200
400	Whse.	Sq. Cage	2200	514
400	Marathon (2)	Sq. Cage	2300	3600
400	G.E.	Slipring	2300	514
400	El. Machy.	Synch.	2300/4000	400
350	Br. Boveri b.b.	Sq. Cage	4000/440	720
350	G.E.	Sq. Cage	2300	1200
350	G.E.	Slipring	440	1200
350	Allis Ch.	Slipring	2300/4000	600
350	G.E.	Slipring	220/440	900
300	Whse.	Synch.	440	1200
300	G.E.	Slipring	220/440	514
300	G.E.	Sq. Cage	2300/440	1200
250	G.E.	Sq. Cage	2300/440	450
250	Gen. Elec.	Sq. Cage	440	3600
250	G.E. TEFC	Sq. Cage	440	1200
250	Whse.	Sq. Cage	2300/440	600
250	Whse. (4)	Slipring	2300/440	600
200	G.E. b.b.	Sq. Cage	220/440	720
200	G.E.	Slipring	220/440	450
200	G.E.	Slipring	440	600
200	G.E.	Slipring	2300	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	2300/440	720
150	Whse. XP	Sq. Cage	440	3600
150	G.E. (4)	Slipring	2300/440	600
150	G.E. (2)	Sq. Cage	2300/440	1800
150	Whse.	Slipring	220/440	1200
150	G.E.	Sq. Cage	2300	900
125	A.C. TEFC	Sq. Cage	220/440	1800
125	El. Machy. (2)	Synch.	220/440	400
125	G.E. TEFC	Sq. Cage	2300	3600
125	Al. Ch. TEFC	Sq. Cage	220/440	600
125	G.E. (2)	Slipring	220/440	514
100	Whse. TEFC	Sq. Cage	220/440	1200
75	G.E. b.b. (5)	Sq. Cage	220/440	1200

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Gen. Elec.	CY-221	250/350	1200
200	Gen. Elec.	BC	250	1450
100	Delco b.b.	Into	120/240	1200
75	Allis Ch. b.b.	EB-146L	125	1800
75	G.E. b.b.	CD	250	1750
60	Ideal	D	125	1150
60	G.E. b.b.	CD	600	1750
50	G.E.(2)	CD-1129	250	1200

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
60	Reliance b.b.	250-T	230	1750
250	Cr. Wh.	101-H	230	1150
200	G.E. (2)	BC-38	230	1150
200	Whse. b.b.	8K	250	287/575
150	Rel. TEFC b.b.	2550-P	230	850
150	Whse.	8K-510	230	230/1000
125	G.E.	CD-173	230	575/1150
100	Elliott b.b. T.E.	JH-FE	230	1150
100	El. Dyn. b.b. (2)	30-S	230	450/1200
80	Whse. dyn. b.b.	8K-122L	250	1800/3600
75	Whse. (2)	8K-160	230	550/1150
75/100	Whse.	8K-191	230	300/600
60	G.E. TEFC b.b.	CD-135	230	1150
50	G.E.	RP-16	230	250/1000
50	Century new	DN-514	230	1150/1750
40	Whse.	8K-163	230	300/1200

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
600	Allis Ch.	440 AC	250 DC
300	Whse. (2)	2300/440 AC	250 DC
200	Gen. Elec.*	220/440 AC	125 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
125	Whse.	220/440 AC	250 DC
100	Delco b.b.	220/440 AC	120/240 DC
80	Star b.b. Synch.	220/440 AC	250 DC
75	G.E. b.b.	220/440 AC	250 DC
75	G.E.	220/440 AC	125 DC
50	G.E. b.b. (3)	220/440 AC	250 DC
25	Reliance b.b.	220/440 AC	250 DC

Arthur Wagner Co. Certified

MO nroe 6-7409
1435 W. RANDOLPH ST
CHICAGO 7, ILLINOIS

Circle 507 on Reader Service Card

FOR SALE
14 NEW TURBINES

4 horizontal, 10 vertical, Westinghouse
Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.
Will sell turbines separately if desired.
Price reasonable.
Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volts. Used one year.

G. M. De ROSE
2457 WOODWARD AVE.
706 DONOVAN BLDG.
DETROIT 1, MICH.

Circle 508 on Reader Service Card

MODERN GE RECTIFIERS

3/60/13,200 AC to 600V. DC

4—1000KW Mod. 6RC-45-CD6
2— 500KW Mod. 6RG-45-CH2

Six Tube Ignitron Pump Type
Full Automatic AC & DC Controls

Can be inspected on original locations now in 1948, still like new, actual photos are available, very low price for lot.

S. M. DAVIS
525 N. 20th, E. St. Louis, Ill.

Circle 510 on Reader Service Card

DUAL FUEL DIESEL ENGINE GENERATOR UNITS

1250 KVA Worthington supercharged dual fuel diesel engine generator unit 3 phase—60 cycle 2400/600/480 volts 360 RPM New 1949—Excellent condition

1050 KVA Nordbarg supercharged dual fuel diesel engine generator unit 3 phase 60 cycle 2400 volts 327 RPM New 1947 — Excellent condition

The above units are still installed and can be shown in operation.

INTERNATIONAL POWER MACHINERY CO.
1612 Union Commerce Building
MAin 1-9514
Cleveland 14, Ohio

Circle 509 on Reader Service Card

POWER EQUIPMENT

6000 KW, G.E. Cond. Turbo-Generator 3/60, 2400 V, 3600 RPM, 200 PSI
5000 KW, West. N.C. Turbo-Generator 3/60, 2400 V, 3600 RPM, 850 PSI, 850°—150# B.P.
1000 KW, Worth.-Moore, Cond. Ext. Turbine, 3/60, 245/490V, 3600 RPM, 130-300# I.P., 10# Ext.
500 KW, West. Cond. Turbo-Generator 480V, 3600 RPM, 200 PSI, 15-30# Extraction
640 HP, B & W, Water Tube Boilers (4) 200# Sectional Header
1500 KW, West. Motor Generator Sets (2) 3/60, 2300/4600 Volts A.C.— 250 Volts D.C., 514 RPM

BREW, WOLTMAN
& COMPANY, INC.
50 CHURCH ST., NEW YORK 7, N. Y.

Circle 511 on Reader Service Card

COMPLETE MODERN 400 LB. POWER PLANT

3750 KVA Elliott Turbine Generator—563 H.P. Wickes Boiler 475 PSIG W.P.

Turbine is 440 PSIG 750° FTT Generator is 3/60/2400/4160. Surface Condenser and all auxiliaries.

This plant is complete in all respects and can be inspected as originally installed. Photographs, prints and specifications available

Other turbine Generators

1-1500 KW Westinghouse	600# 750° Non-Cond. 150# BP 2400V
1-2000 KW GE	600# 750° Non-Cond. 150# BP 4160V/6600V
2-3000 KW GE	600# 750° Non-Cond. 150# BP 2400/4160V
1-2500 KW Allis Chalmers	400# Autext 150° Non-Cond. 30# 480V
1-2500 KW Westinghouse	125# Non-Cond. 10# BP 2300V
1-2500 KW GE	400# 750° Autext 25# Condensing 600V

Coble Address: CHASWEAVER

CHARLES WEAVER, INC.

19701 JAMES COUZENS HIGHWAY

DETROIT 35, MICHIGAN

Telephone: BRoadway 3-1900

Circle 512 on Reader Service Card

NEW SURFACE CONDENSERS

Size Sq Ft.	Make	Tubes	Passes
400	Allis-Chalmers	⅝" Admiralty	2
436	C. H. Wheeler	⅝" Cup. Nick.	2
580	Foster-Wheeler	⅝" Cup. Nick.	2
725	C. H. Wheeler	⅝" Cup. Nick.	2
1050	N.Y. Shipbuilding	⅝" Cup. Nick.	2
1350	Alco Products	⅝" Cup. Nick.	2
2000	N.Y. Shipbuilding	⅝" Cup. Nick.	2
2200	Alco Products	⅝" Cup. Nick.	2
3500	N.Y. Shipbuilding	⅝" Cup. Nick.	2
11000	N.Y. Fost.-Wheeler	⅝" Admiralty	2

EASTERN SCRAP & SALVAGE CORP.

65 Muirhead Ave., Trenton 7, N. J.

OWen 5-6351

Circle 513 on Reader Service Card

BABCOCK & WILCOX COAL PULVERIZERS

2—NEW UNUSED Babcock & Wilcox coal pulverizers, Type E-56, each equipped with American Blower Corporation air fan, 15,000 cfm capacity with motor drive. These are complete coal pulverizer installations with blower air fans, attached and unattached structural parts, capacity 20,000# coal per hour each pulverizer. Exceptional bargain.

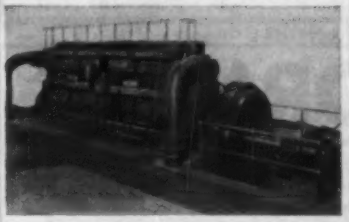
UTILITIES MACHINERY CORPORATION

1965 East Sixth Street, Cleveland 14, O.

Circle 514 on Reader Service Card

DIESEL ENGINE GENERATOR SETS

Immediate Delivery from Inventory!



Any voltage; 50 or 60 cycle. Available in stationary, mobile or portable model. Following listing is only partial.

1420 kva Fairbanks-Morse model 38D—8⅛ (photo above)
1375 kva General Motors model 278A
1250 kva General Motors model 567
938 kva General Motors model 567
625 kva General Motors model 278A
625 kva American Locomotive Co. model 539
412 kva Worthington model CC
375 kva General Motors model 268A
312 kva General Motors model 268A
250 kva General Motors model 268A

A. G. SCHOONMAKER Company, Inc.

Foot of Spring St., Sausalito, Cal. Edgewater 2-1490

50 Church St., New York 7, N. Y. Digby 9-4351

Circle 515 on Reader Service Card

LIQUIDATION

MODERN BOILER PLANT

5—B & W 70,000#/hr Boilers, 600 psi. (1953)
1—B & W 80,000#/hr Boiler, 600 psi. (1946)
1—Graver Water Softening Plant.
1—Graver Water Treating Plant.
1—Carrier Cent. Blower, 3 stg., 38,300 cfm.
1—Carrier Cent. Comp., 6 stg., 9370 cfm.
1—Carrier Cent. Comp., 3 stg., 5535 cfm.
6—B. J. Cent. Pumps, 7000 gpm, 120' head.
1—D. H. Cent. Pump, 4500 gpm, 116' head.
1—Worth. Cent. Pump, 2750 gpm, 100' head.
2—A. C. Cent. Pumps, 2250 gpm, 165' head.
1—I.R. Cent. Pump, 1200 gpm, 300' head.
1—Pac. Cent. Pump, 1200 gpm, 290' head.
2—Lummus Surface Condensers, 6100 & 2250 sq. ft., Admiralty tubes.

WIRE PHONE WRITE

BRILL EQUIPMENT COMPANY

DESTREHAN, LA. Tel: Norco 6571

Home Office:
35-51 Jabez St., Newark 5, N. J.
Tel: Market 3-7420

Circle 516 on Reader Service Card

37 Years Dependable Service

SLIP RING MOTORS 3 Ph., 60 Cy.

H.P.	Volts	Make	Speed
500	4000/2300	G.E.	600
450	4000/2300	G.E.	1200
400	4000/2300	Whse.	720
300	4000/2300	G.E.	720
250	440	G.E.	900
300	440	G.E. (hoist)	600
300	440	Whse.	3600
225	4000/2300	G.E. (hoist)	600
200	2300	G.E.	600
200	2300/440	G.E.	720
150	230/440	Whse.	720
125	2300	G.E.	900

AC GENERATORS or SYN MOTORS, 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300	G.E.	TS	1800
400	2300/440	G.E.	ATI	720
300	440/220	G.E.	TS	450
300	2300/440	G.E.	TS	1200
200	440	G.E.	TS	900
150	440/220	Whse.	G	1200
125	440/220	Whse.	HR	600

SQUIRREL CAGE MOTORS

500	2300/4000	Elliott	SC	1800
400	2300	G.E.	FT	3600
400	2300/4000	G.E.	K	1200
350	2300/4000	G.E.	SEDP	3600
350	2300/4000	G.E.	K	600
300 (3)	2300	G.E.	FT	3600
300	2300/4000	L. Allis.	FS	1800
300	2300/440	G.E.	SEDP	1200
300	2300/4000	Cont'l.	spl.-Prf.	720
300	2300/440	G.E.	KT	900
250	2300/4000	G.E.	K	720
200	2300	G.E.	KT	1800
200	2300	Cont.	TEFC	3600
150	440	Whse.	X-pf.	3600
150	440/220	Cont'l.	X-pf.	1800
150	440/220	G.E.	TEFC	720
150	2300/440	G.E.	KT	900
150	2300/440	G.E.	TEFC	3600
125	2300/440	G.E.	FT	1200
100 (3)	4000/2300	L. Allis.	K	600
100	2300	Cont'l.	OX	1200
60 (3)	440	Cont'l.	X-pf.	1800

CIRCUIT BREAKERS, 3 Pole

4—1200 Amp., DA-50, Whse., 600 V., Air
1—600 Amp., Al. Chal., 15 KV, Outdoor
6— 600 Amp., R. Smith, 7.5 KV, Sol. oper.
1— 400 Amp., R. Smith, 7.5 KV, outdoor, New

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
150	230	Ml. Dyn.	B/brg.	880
60/75	230	G.E. (new)	CD	600/1600
90	230	G.E.	CD	1750
60	230	G.E.(4)	CD	1150

MOTOR GENERATOR SETS

KW	Make	Input-AC	Motor Type	Output V., DC
300	Whse.	4150/600	Syn.	260/125
150	G.E.	440/220	Syn.	250
135	G.E.	440/220	Sq. Ca.	125
100	G.E.	2300/440	Syn.	250
75	Cr. Wh.	440/220	Sq. Ca.	260/130
70	El. Dyn.	440	Sq. Ca.	70
65	G. E. B	2300/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

1—500 kva, Al Ch. 2400/4160Y—600 volts, 3 ph.
3—500 kva, G.E., 12800—346/600 V.
3—200 kva, Mol., 12,800—2300 V.
3—333 kva, G.E., 12,800—2400 V.
3—333 kva, G.E., 2400—240/120 V.
3—200 kva, G.E., 13,800—480 V.
3—200 kva, G.E. 4150—480/240 V.
3—167 kva, Whse., 4150—480 V.
3—150 kva, Al. Ch., 2400—220 V.
3—150 kva, G.E., 13,800—2300 V.
3—100 kva, Whse., 4800/2400-240/480 V., Dry
3—100 kva, G.E. 2400—120/240 V., Pyr.

GASOLINE—ENGINE GENERATOR SETS

3—37½ kva, 1800 R, 220 V 3/60, Cont'l., 6 cyl.

only partial listing

STEPHEN HALL & CO.
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

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PROMPT, EFFICIENT

DIESEL ENGINE *MAINTENANCE SERVICE*

AT YOUR INSTALLATION SITE OR IN OUR PLANT!

On-the-job repair, overhaul or periodic maintenance for minimum downtime by our expert servicemen available on call. Complete stock of replacement parts for all makes of diesel engines.

Inquire about our **UNIT EXCHANGE PLAN** that avoids costly downtime and can save you money. Applies to Fairbanks-Morse model 38D, Cleveland models 278A and 268A, GM Electro-Motive Division model 567.

Write for full information on all maintenance services

A. G. SCHOONMAKER *Company, Inc.*

Foot of Spring St., Sausalito, Cal.
EDgewater 2-1490
50 Church St., New York 7, N.Y.
Digby 9-4351

Circle 518 on Reader Service Card

TRANSFORMERS

BOUGHT · SOLD · RENTED

REWOUND · RE-DESIGNED

MANUFACTURED

Ask for our Stock List

For Sale

3—2500 KVA G-E 69000—2300Y
3—2500 KVA G-E 69000—2400/4160Y
3—2500 KVA G-E 69000—7200/12470Y
4—2500 KVA W-H 34500—2400/4800
3—1500 KVA G-E 69000—2300Y
3—1500 KVA G-E 69000—2400/4160Y
3—1500 KVA G-E 69000—7200/12470Y

THE ELECTRIC SERVICE CO., 5322 Hetzel St., Cincinnati 27, Ohio
"America's Exclusive Independent Transformer Service Shop"

Circle 519 on Reader Service Card

FOR SALE

1500 KW, 80% Power Factor, 3 phase, 60 cycle, 2300 volts, 3600 RPM, General Electric noncondensing steam turbine generator unit, 375 PSIG, 700° FTT, 125# exhaust back pressure, complete with direct connected shaft exciter and switchgear. Excellent condition—available immediate delivery.

EUCLID ENGINEERING CORPORATION
909 National City East Sixth Building
Cleveland 14, Ohio

Circle 520 on Reader Service Card

FOR SALE!!

"As Is — Where Is"

ONE—1450 K.W. 3-Phase, 60 cycle, 2300 volt Steam Power Plant. Complete with boilers and auxiliaries, turbo-generators, condensers, switchboard, spray pond equipment, etc. Will sell as a whole, or in part.

If interested, wire or write for detail description.

TIP H. ALLEN
General Superintendent
Canton Municipal Utilities
Canton, Mississippi

Circle 521 on Reader Service Card

NEW EQUIPMENT FROM THE UNCOMPLETED

BATTLESHIP U. S. S. KENTUCKY

Installed but never used
Built of finest materials

WESTINGHOUSE 1250 K.W. TURBO-GENERATORS

(4)—Westinghouse—440/3/60—850°—540 lbs. working pressure. Complete with condensers, circulating pumps, etc.

MAIN CONDENSERS

Mfg. by Foster-Wheeler—23,500 sq. ft. cooling surface—40,500 GPM circulating water—total tubes 8,976, or cupro-nickel, as follows: (550) each ⅝" x 0.066 and (8416) each ⅝" x 0.049. Monel water boxes.

BOILERS

7 B&W EXPRESS TYPE

Design pressure 634# — operating pressure 565# — temp. 850°F. Oil fired — separately fired superheaters. *Capacity: 210,000 lb.* steam/hr. ideal for testing where large quantities of steam are required, giving excellent control from separately fired superheaters.

LARGE DEAERATING FEED HEATERS

Monel construction—spray type—capacity 480,000 lbs./hr.—vent condenser—single pass—heating surface 174 sq. ft.—all Monel construction.

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELIGIN 5-5050 — LEXINGTON 9-1900

Circle 522 on Reader Service Card

EXCELLENT TRANSFORMERS

3—833 KVA WESTINGHOUSE

3—833 KVA Westinghouse transformers Type SL, Class OA Voltage rating 55,000 to 2400 Volts, with taps below, Impedance 7.1%. Exc. Condition.

3—250 KVA General Electric Pyranol Transformers, Type H. Form RA, 2400/4160Y to 240/480 V., w/Taps, Excellent Condition.

Write For Complete Listing

MACHINERY CENTER INC.
PO Box 964 HU 4-7601 Salt Lake City 10, Utah

Circle 523 on Reader Service Card

MODERN BOILERS

2—50,000#s per hour C-E boilers, 250 psi, coal and oil fired. Units are complete with water walls, forced and induced draft fans, all valves, soot blowers, Republic controls and auxiliary equipment.

1—110,000#s per hour C-E boiler, 675 design pressure, saturated temperature but provision for superheater, coal and oil fired, water walls, airheater, all valves, soot blowers, forced and induced draft fans. Bailey controls.

MIDWEST BOILER & TURBINE CO.
Warner, New Hampshire

Circle 525 on Reader Service Card

POWER EQUIPMENT DIVISION

BOILERS

3—1296 HP B&W Sect. Steel Header 275 PSI Gas/Oil Fired
2—200 HP 160 PSI Keeler, Stoker Fired
12—NEW UNASSEMBLED B&W, F.W. C.E. with Superheater, Economizer, Soot Blowers, Oil Burners, Steel Encased—Rated:

122,500#/hr, 565 PSI, 850°F
44,500#/hr, 450 PSI, 735°F
35,000#/hr, 285 PSI, 577°F

A. C. MOTORS — 3 ph. 60 Cy.

Qu.	HP	Make	Type		Speed	Volt
1	350	A.C.	AZZ	TEFC X.P.	3600	2300
1	250	Cont.	NP	TEFC X.P.	720	2300
1	200	G.E.	KF	TEFC X.P.	3600	2300
1	125	G.E.	KF	TEFC X.P.	1800	2300
3	100	G.E.	K	TEFC X.P.	1800	440
1	150	West.	CW	Slip Ring	1800	440
3	75	West.	CW	Slip Ring	1800	440
3	50	West.	CW	Slip Ring	1200	440

GENERATOR SETS

11—1250 KVA Natural Gas Engine Sets 3/60/2400/4160 with switch gear *(can be seen running)*
1—500 KW Condensing 200 PSI Turbine
1—500 KW G.E. Non Cond. 265 PSI, 0-10# BP Turbo Generator

TRANSFORMERS

1—6000 KVA 3/60/44,000—4160 Substa.
3— 333 KVA 1/60/2400/4160 Y—480

CRANES

4/10 ton OET 47'3" Span 75' Lift AC
25 ton Powerhouse 36'6' Span AC

HEAT & POWER CO. INC.

60 East 42nd St., New York 17, N.Y.
310 Thompson Bldg., Tulsa 3, Okla.

Circle 526 on Reader Service Card

DIESEL ENGINE PARTS
for Fairbanks-Morse model 33F16 and 37F16
HEADS • CYLINDERS • PISTONS • BEARINGS

A. G. SCHOONMAKER Company, Inc.

Foot of Spring St., Sausalito, Calif. ED 3-1490
50 Church St., New York 7, N. Y. Digby 9-4831

Circle 527 on Reader Service Card

For Sale, Lease or Trade

4 General Electric Steam Turbines
30,000 SHP Cross Compound
Ahead & Astern Element
525 lbs. steam pressure
Weight complete 39,000 lbs.
Estimated cost $90,000.00 ea.

4 Reduction Gears for above units
General Electric
Double Reduction—Double Helical
Weight approx. 78,000 lbs.
Estimated cost $90,000.00 ea.

6 4600 HP Generators
3 phase General Electric
Cost $50,000.00 ea.

All items unused & Good
Will sell at fraction of cost

PROGRESSIVE METAL PRODUCTS
457 Cortlandt St., Belleville, N.J.
Plymouth 9-3034

Circle 528 on Reader Service Card

MISS POWER EQUIPMENT SAYS,

"For BIGGER SAVINGS and BETTER SERVICE, Get Our BARGAIN PRICES on Guaranteed NEW and REBUILT MOTORS"

SQUIRREL CAGE MOTORS NEW AND GUARANTEED REBUILT

HP	Make		Type	Speed
500	L.A.	B.B. Splash. 440 Volt	FX-1408	3600
400	West.	B.B. Drip	CSP-681	1800
400	L.A.	B.B. Splash		1800
400	G.E.	S.B. Open	IK	1200
400	G.E.	S.B. Open	IK-17B	900
400	West.	S.B. Open	CS	900
300	G.E.	S.B. Open	IK	1800
300	G.E.	S.B. Open	KT	1200
300	G.E.	S.B. Open	IK	900
300	G.E.	S.B. Open	IK	720
300	G.E.	S.B. Open	KT-561	729
300	West.	S.B. Open	CS-1002	600
300	G.E.	S.B. Open	IK	600
250	El. Dyn.	T.E.F.C.B.B.	KNX	1800
250	G.E.	S.B. Open	KT	1800
250	West.	B.B. Splash	CS-875	1800
250	G.E.	S.B. Open 2200 Volt	IK-16	1200
250	G.E.	S.B. Open	IK	1200
250	G.E.	S.B. Open	IK	900
250	G.E.	S.B. Open	IK	720
200	West.	S.S.B. Open	CS-855	1800
200	West.	S.B. Open	CS	1200
200	G.E.	S.B. Open	IK-15	1200
200	G.E.	S.B. Open	IK-15B	1200
200	G.E.	S.B. Open 2200 v.	IK	1200
200	G.E.	S.B. Open	IK	900
150	LA	TEFCBB	JX-114	3600
150	G.E.	S.B. Drip	K-6324	1800
150	West.	S.S.B. Open	CS-771-C	1800
150	West.	S.S.B. Open	CS-710C	1800
150	Al. Chal.	B.B. Open	AR	1800
150	West.	S.B. Open 2200V	CS	1800
150	West.	B.B. Drip	CS-772	1200
150	G.E.	B.B. Open	KT	1200
150	F.M.	B.B. Open	H-24A	900
150	G.E.	S.B. Open	IK	900
150	G.E.	S.B. Open	KT-558	900
150	G.E.	S.B. Open	IK	720
100	West.	S.S.B. Open	CS-870-C	600
125	G.E.	TEFCBB	K	3600
125	Burke	B.B. Open 440 Volt	M-505	3600
125	Cont.	TEFCBB	XP AP-109	1800
125	G.E.	S.B. Open	IK	1800
125	West.	S.S.B. Open	CS	1800
125	Al. Chal.	B.B. Open	AR	1800
125	West	TEFCBB	CS855	1200
125	G.E.	S.B. Open	KT-553	1200
125	G.E.	S.B. Open	IK	1200
125	F.M.	B.B. Open	H	900
125	G.E.	S.B. Open	IK	720
125	G.E.	S.B. Open	IK	600
100	Cont	BB Splash	N564	1200
100	Howell	TEFCBB	G-505	3600
100	Cont.	TEFCBB	XP AP-505	1800
100	G.E.	S.B. Open	KT-543	1800
100	G.E.	B.B. Open	K-564	1800
100	LA	TEFCBB	JX-113	1800
100	West.	TEFCBB	CS-770	1200
100	G.E.	S.B. Open	KT-547	1200
100	West.	SSB Open	CS-007	1200
100	F.M.	B.B. Open	H28C	900
100	F.M.	B.B. Open	H	720
100	F.M.	B.B. Open	H	600
75	Reliance	S.B. Splash	505	1200
75	F.M.	B.B. Open	H	900
75	F.M.	B.B. Open	H	900
60	West.	TEFCBB	CS-445	3600
60	G.E.	TEFCBB	KF-445	3600
60	L.A.	TEFCBB-XP	EX-445	3600
60	L.A.	TEFCBB	JX-445	3600
60	West.	TEFCBB	CS-445	1800
60	Cont.	TEFCBB	NP-504	1800
60	G.E.	TEFCBB	K-504	1800
60	West.	TEFCBB	CS-505	1800
60	G.E.	S.B. Open	K-444	1800
60	West.	B.B. Open	CS-444	1800
60	West.	S.S.B. Splash	CS-445	1800
60	Wagner	TEFCBB	CP-445	1800
60	G.E.	B.B. Open	K-444	1800

CASH FOR YOUR SURPLUS
SEND YOUR LIST TODAY! NEW & USED Electrical Equipment

FREE CATALOG. This is a partial listing. We are continually changing our stock, and can fill your requirements at any time. Send for our free catalog. In Stock, fractional horsepower up to 500.

Motors, Control Equipment, AC and DC Generators, MG sets and transformers.
PHONE or WIRE us COLLECT
LARGE LINE OF SLIP RING MOTORS & CONTROLS.

POWER EQUIPMENT CO.

8 CAIRN STREET • PHONE BEverly 5-1662 • P. O. BOX 534 • ROCHESTER 7, N. Y.

Circle 529 on Reader Service Card

DIESEL ENGINE GENERATOR UNIT

575 HP, 600 RPM, Worthington Type DH-6 Diesel engine direct connected to 500 KVA—400 KW, 80% PF, 600 RPM, 3 phase 60 cycle, 240/139 volts Electric Machinery synchronous generator complete and equipped with exciter, switchboard with instruments, attached and unattached auxiliaries to the engine. Slightly used—practically new. Immediate delivery.

UTILITIES MACHINERY CORPORATION
1965 East Sixth Street, Cleveland 14, O.

Circle 530 on Reader Service Card

FOR SALE

675 HP COOPER-BESSEMER DUAL FUEL DIESEL-GAS. 500 KW. 3/60/2300V. COMPLETE.

1275 HP COOPER-BESSEMER DUAL FUEL DIESEL-GAS. 900 KW. 3/60/2300 V. NEW 1953.

3000 KW GE CURTIS CONDENSING TURBO. 400# ISP. 3/60/2300 VOLTS. BUILT 1930. COMPLETE. EXCELLENT.

WHISLER EQUIPMENT CO.
1908 Railway Exchange Building
St. Louis 1, Mo.

Circle 531 on Reader Service Card

GUARANTEED "REBUILT" POWER EQUIPMENT

SLIPRING MOTORS
3 ph 60 cy 220 or 440 volts

HP	RPM	MAKE	TYPE
1500	514*	Al.-Ch.	Mill Type
1500	360*	Al.-Ch.	Mill Type
900	160*	Al.-Ch.	Mill Type
600	1800*	G.E.	M-6345B, Dppf, Mew
500	1200	G.E.	M-6345Z, Dppf,
400	720	G.E.	MT-575Y
350	900*	West.	CW
350	1800*	Al.-Ch.	ARYW(2)
300	1800	Cr.-Wh.	BR
300	600	G.E.	I-M-17A
300	600*	F.-Morse	HV-H3000, BB
300	450	G.E.	I-M, 2 or 3 brg.
250	720*	G.E.	I-M-17A
250	600*	West.	CW
250	600*	West.	CW, 2 or 3 brg.
200	600*	G.E.	I-M-16
200	600	West.	CW-1000 (2)
150	1800	Cr.-Wh.	Size 30-R
150	720	G.E.	MT-5628

*2200 volts or higher

SQUIRREL CAGE MOTORS
3 ph. 60 cy. 220 or 440 volts (*2200 volts or higher)

HP	RPM	MAKE	TYPE
1250	3600*	Al.-Ch.	ANX
800	1800	West.	CS84C
650	600*	West.	CS-44-C15 Dppf (2)
500	1200	G.E.	I-K
400	1800*	L. Allis	BB, Sppf.
400	1800	West.	BB, Dppf.
400	1200	G.E.	KTP-565
350	3600	Cr.-Wh.	SC, Dppf.
300	1200	G.E.	KT-550, Dppf.
300	600*	West.	CS-39A
300	600*	West.	CS-1002
300	400	Elliott	Design 40Y68
250	1800	G.E.	KT-550
250	1800	West.	CS-8120B, TEFC, Xpf.
250	1200	G.E.	KTP-561
250	1200	G.E.	I-K
250	720	West.	CS-1000
200	1800*	G.E.	I-K-13B
200	1800	West.	CSP-5815, Dppf.
200	1200	G.E.	K-6334B, Dppf.
200	900	West.	CS-874S, SBB
200	900*	West.	CS-830A
200	720*	Al.-Ch.	AN-37G
200	720	G.E.	KF-5648
200	600	West.	CS-1010

M.G. SETS

KW	Make	Motor A.C.V.	Generator D.C.V.
1000	West.	4160	250
600	G.E.	(8 unit)	2300/440syn. 125/250
500	West.	2300/440syn.	125/250
400	Al.-Ch.	2300/440syn.	125/250
300	West.	2300/440syn.	250
200	Rel.	2300/440syn. TS	500
200	G.E.	2300/440syn.TS	250/275
200	Ridgwy	2300syn.	250
150	Al.-Ch.	220/440/220	250
150	West.	2300/440/220syn.	125/250
125	West.	2400/480syn.	250
125	G.E.	2400/480syn.	250
100	West.	2300/4000syn.	230/275
100	G.E.	2300/4160syn.	250
100	G.E.	2300/4000	125
100	El-My.	220/440syn.	125
75	West.	2300/440/220	250
60	G.E.	220/440	250
50	El-My.	220/440	250
50	G.E.	220/440	250
50	West.	220/440	125
35	West.	220/440	250
35	G.E.	220/440	250
30	G.e.	(2) 220/440	125
25	G.E.	220/440	125
15	Ideal	220/440	125

Phone **CANAL 6-2900**

CHICAGO Electric Co. 1320 W. CERMAK RD. CHICAGO 6, ILL.

Circle 532 on Reader Service Card

UNUSED—ASSEMBLED—NEW

IN ORIGINAL MANUFACTURER'S PACKING CRATES

BOILERS (Package type)

B&W—60,000 lbs./hr.—475 psig., 740°TTF, oil fired (shipped intact as one integral unit)
B&W—122,500 lbs./hr.—835 psig., 850°TTF, oil fired (unassembled)

TURBOGENERATORS

4600 KW GE Turbine—Gen Set, Cond 410psi, 725°TTF, 28.5 Hg exh, 3/93.3/2700V PF 1.0—New
1800 KW GE Turbine—Gen Set, Cond 410psi, 725°TTF, 28.5 Hg exh, 3/60/1735 V PF 0.8—New
1000 KW GE Turbine—Gen Set, Cond 200psi, 600°TTF, 28.5 Hg exh, 3/60/2400V PF 0.8

STEAM TURBINES

1000 SHP GE Cruising Cross Compound, 535psi, 825°TTF, 81psi exh, 10,119/350 RPM with Falk reduction gears—New
3000 SHP GE HP Main propulsion turbine 410psi, 9040RPM, 725°TTF
3000 SHP GE—LP Main propulsion turbine 40psi, 9040RPM
} 1 Set—New
11,550 SHP GE HP 12 Stage Cross compound turbine 525 psig, 825°TTF 5870RPM
13,450 SHP GE LP 48psig, 4714RPM with Westgh speed decreaser gear assy.
} 1 Set—New
394 HP Worthington-Moore, Non-Cond, Form #52R, 310psig, 650°TTF, 2psi-exh, 3560RPM

PUMPS, CENTRIFUGAL (Motor driven)

263 GPM @ 375'TDH, Ingersoll Rand—2GT, w/60HP 3525RPM 3/60/220/440V (Used)
275 GPM @ 635'TDH, Ingersoll Rand—2GT, w/75HP 3525RPM 3/60/2300V (Used)
200 GPM @ 1300'TDH, Ingersoll Rand—½CNTA, w/Base, Motor optional

PUMPS, CENTRIFUGAL (Turbine driven)

460 GPM @ 750psi discharge, Worthington, w/350HP turbine, 575psi, 4900RPM—New

BLOWERS, TURBO-CENTRIFUGAL

20,000 CFM @ 17"WC, Westinghouse, Vaneaxial, w/Turbine, 82.5HP, 375psi, 10psi—exh, 4625RPM—New
24,000 CFM @ 26"WC, Sturtevant Co, Rexvane, w/Turbine, 191HP, 400 psi, 10psi—exh, 3525RPM—New
43,000/50,000 CFM @ 8"/11"WC, Sturtevant, Turbovane, w/Turbine 88/141HP, 400psi, 10psi —exh, 4980/5870RPM—New

WABASH POWER EQUIPMENT CO.

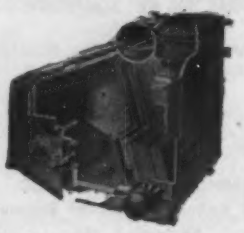
9750 SKOKIE BLVD., CHICAGO (Skokie), ILLINOIS

TEL. OR. 3-8118

Circle 539 on Reader Service Card

BOILERS

NEW UNASSEMBLED



# Steam/hr.	Key	PSI	Temp.
122,500	DF	565	850
121,650	DF	565	850
60,000	SF	435	750
74,000	H	280	500
55,000	A	240	—

DF Double Furnace, SF Single Furnace (illustrated), bent water tube boilers w/economizers and superheaters, B & W's and
A Foster Wheelers.

Header type, straight tube, B & W.

H 3 drum, single furnace, Wickes.

Pelnik-Loconti Industrial Supply, Inc.

315 Oriskany St., Yorkville, N.Y.

Utica, N. Y. Ph. RE 6-4621, RE 2-4513

Circle 535 on Reader Service Card

COAL HANDLING EQUIPMENT

Fairfield Eng. Co. for 25 ton per hr. unit consisting of R.R. track hopper; reciprocating feeder, 16" x 56' belt conveyor, 60' bucket elevator, 100' flight overhead conveyor, 75' overhead 350 ton steel coal bunker, 100' Stock Equip. Co. enclosed drag type under bunker conveyor with 3 triple & 3 intermediate valves. Replacement cost $80,000, our price $10,000.

WATER SOFTENER SYSTEM

Graver 4800 gal. per hr. Deaerating hot process type with Gravor spray type raw water heater, pressure filters, chemical tanks, pumps, sludge water & flow meters. Replacement cost $35,000. Our price $5,000.

TURBO GENERATOR UNIT

Allis Chalmers A.C. 800 K.W. Generator 1000 K.V.A. 80% power factor 3 phase 60 cycle 1200 R.P.M. Terry Multistage Turbine, type G.T.F.T. 4500 R.P.M. reduced by gear to generator speed of 1200 R.P.M. develops 950 K.W. at 95% power factor, complete with Allis Chalmers 5000 volt switch gear & 5 K.V. 600 amp. circuit breaker. Replacement cost $108,000, our price $31,500.

ELECTRIC CRANE

P & H overhead 5 ton "TRAVLIFT" electric crane 32' span x 75' travel hand geared trolley and bridge, type TEELR-3 powered by 3 P.H. 7½ H.P. 220/440 Motor, 18' left, push button floor control. Used 20 hours. Replacement cost $9,700, our price $3,650. Equipment used only 16 months, guaranteed as new. Many more Power House items. Write for brochure.

A. & L. Z. PROPERTIES CO.

4759 N. Larkin St., Milw'kee 11, Wis.

Circle 537 on Reader Service Card

AUTOMATIC and MANUAL
Gas or DIESEL GENERATOR UNITS
Complete Switchboard Design and Construction
USED & REBUILT EQUIPMENT
UNIVERSAL POWER ENGINEERING CO.
382 Wayne St. Jersey City, N. J.
Phone: DElaware 2-8300

Circle 536 on Reader Service Card

USED AMESTEAM PACKAGE BOILERS

2—100 H.P., 150 psi, #2 & 6 oil, complete with controls, valves, injectors, fuel pumps & oil heaters. Excellent condition.

E. A. DRAKE INC.

Box 113, Salina Sta. Syracuse 8, New York

Circle 538 on Reader Service Card

ELECTRICAL POWER EQUIPMENT

A. C. MOTORS—3 ph. 60 Cy.

SLIP RING

Qu.	HP	Make	Type	Volts	Speed
1	1750	G.E.	M-579BR	4800/3400	1800
1	1500	G.E.	MT-6	6600	1187
1	800	Whse.	CW	550	1775
1	600	Whse.	CW-432D-16	440	1778
1	500	Whse.	CW	550	850
1	300	G.E.	MTP-561	2300	1800
1	250	G.E.	MT-524Y	4000	257
1	250	Cr. Wh.	812ZE-290	2300	850
1	250	A.C.		550	900
1	200	G.E.	IM	2300	880
1	200	G.E.	IM	2300	435
2	200	Whse.	CW-390	2300	1775

SQUIRREL CAGE

1	850	Whse.	CS-1115	2300	900
1	500	G.E.	PT-530AY	2300	3600
4	500	Whse.	CS-1216	2300	500
3	500	G.E.	KP	2300	3600
2	450	Elliott	3910BB	2300	1200
2	400	Whse.	CS	6600/4000	3565
1	300	Whse.	CS-1002	2300	900
1	200	Whse.	CS-903H	2300	1175/875
1	200	G.E.	KT-557	440	1800
3	200	Whse.	CS-855S	220/440	1750
1	200	Whse.	TEFC CS875C	440	3600

SYNCHRONOUS

1	7000	G.E.	ATI	2240/6600	600
1	3000	G.E.	TS-6438P	2300/4600	300
2	1750	G.E.	ATI	2300	3600
1	1750	G.E.	TS	2300	900

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2100/1750	G.E.	514	250/350	2300/6600
1	2000	G.E.	514	440	2300/4600
1	1500	G.E.	720	600	6600/13200
1	1500	G.E.	514	250	6600/13200
1	1500	G.E.	600	600	2300/4160
1	1200	West.	720	600	2300/4160
1	1000	G.E.	900	260	6600
1	500	G.E.	900	250	2300/4600
1	500	G.E.	900	125/250	440
1	250	G.E.	900	125	440/4160
2	300	G.E.	1200	250	2300
1	300	Whse.	1200	600	2300
1	250	G.E.	900	250	220/440
1	240	West.	900	125	220/440
1	200	El. Mhy.	1200	250	2300/4600

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	1000	G.E.	1502 to Cond 2400 V.
1	4000	G.E.	4002 surface condenser 2400/4150 volts.

TRANSFORMERS

Qu.	KVA	Make	Type	PH	Voltages
2	3333	Whse.	OISC	1	13800x2300
3	1000	G.E.	OISC	1	13800x480
2	750	G.E.	PYR.	1	95/255
2	500	Kuhl.	OISC	1	12300x6600
3	500	Mol.	OISC	1	6600/11430Yx480

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltage
1	5000	G.E.	60/50/60	11000/6600
2	2500	G.E.	25 cy/62.5	2300/2300

RE-NU-BILT BY

BELYEA COMPANY, INC.

43 Howell St., Jersey City 6, N. J.

Tel: OLDFIELD 3-3334

Circle 533 on Reader Service Card

TRANSFORMERS

1—6667 kva, Westinghouse 3/60/115,000Y/13750
1—6000 kva G.E. 3/60000/2400/4160Y
1—2000 kva Nia. Askarel, 3/13800/4160Y/2400
2—1500 kva, Wagner, 1/60 cy. 6900—2400/4160Y
2—1000 kva Westinghouse, 1/22900/480
2—1000 kva Westinghouse, 1/13800/480
1—1000 kva Westinghouse, 1/13800/2400/4160Y
2—1000 kva Standard, 1/44000/6900
2—1000 kva Standard, 1/60000/4160Y/2400
2—1000 kva Standard, 1/34400/48
2—833 Allis Chalmers 1/60/12,000-480
1—800 kva, Westinghouse, 3 phase 4800/480
2—555 kva G.E., 25 cy, 2400/4800—240/480
3—333 kva, Westinghouse, 2400/4800, 240 x 480
3—200 kva Westinghouse, 4800—240x480
3—100 kva G.E., 2400/4160Y—120x240
3— 75 kva G.E., 2400/4160Y—120x240
3— 50 kva WEST CSP, 4160/7200Y, 120/240

ERIE ELECTRIC CO., INC.

28 Mechanic St. Buffalo 2, N. Y.

Circle 534 on Reader Service Card

NEW BOILERS FROM S.S. HAWAII

NEVER USED

8 B&W WATER TUBE BOILERS

With Separately Fired Superheaters

634 pounds working pressure—850° T.T.—6053 square feet generating surface. Capacity 158,000 pounds steam per hour. Capacity plus 20%—190,000 pounds steam per hour. Total dry weight 135,258 pounds. Units complete with burners, economizers, soot blowers, valves, controls, etc.

DIMENSIONS:

Overall width 11'
Height over drum 21'
Depth 15'

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 540 on Reader Service Card

BOILER

Built in 1943 at the cost of $985,000. This water tube generator is designed for 675 lbs. WP. Heating surface 9,100 square feet. Water wall heating surface 1,968 square feet. Tubular air heater. Made to run on pulverized coal or oil. This boiler is complete with pulverize mills, blowers, pumps and etc. Must be moved this year and can be bought cheap enough to dismantle, ship and erect on your site at about ten per cent of cost. For further information write or call:

COREY BUILDING WRECKING
1500 Middlesex Street
Lowell, Massachusetts
Phone: GL. 2-8908

Circle 541 on Reader Service Card

BOILERS — USED

Babcock & Wilcox Type H Sterling Boiler, 25,000 lb. per hr., 160 lb. design complete with all auxiliary equipment and controls (1942). Also available—1901 B & W Chain Grate Stoker Boiler.

THE WELLMAN ENGINEERING CO.
7000 Central Avenue • Cleveland 4, Ohio

Circle 542 on Reader Service Card

BOILER

1—200 HP Keeler, type CP, 180 psi, stoker fired, 1945

COAL PULVERIZERS

1—Kennedy Van Saun 7' x 9' air swept ball mill, integral gear drive.
1—Babcock & Wilcox #32E ball-ring pulverizer, air swept, 75 HP.
3—Raymond #452 bowl mills, 125 HP, prart. UNUSED.

WRITE FOR DETAILS

PERRY EQUIPMENT CORP.
1422 N. 6th St., Philadelphia 22, Pa.
Phone: POplar 3-3505

Circle 543 on Reader Service Card

TRANSFORMERS—60 CYCLE

Qu	KVA	Make	Type	Phase	Voltages
2	3000	Moloney	TCR	3	7200/6600-4160/2400
2	750	G.E.	K	1	4600-120/240
1	200	Penna.	(Askarel)	3	12470Y/7200-240
2	250	G.E.	H Pyranol	1	4800/3450Y/120/240
2	250	West.		1	2300/4600-220/440
3	200	G.E.	HSP2F	1	2400/4160-240/480
3	200	Amer.	CC	1	4160/7200-240/480
3	75	G.E.	KF	1	2400/4160-120/240
3	50	G.E.	H	1	2400/4160-240/120
1	50	Amer.	Abestal	3	4160-120/208Y
4	25	West.	Hypercil	1	2400/4160-120/240

MOTOR GENERATOR SETS

Qu	KW	Make	Speed	DC	AC
1	75	EM	1200	250	Syn. 220V.
1	75	G.E.	1200	125	2300/4160 Syn.
1	100	West.	1200	250	2300/4160Y Syn.
1	175	West.	1200	125	4150 Syn.
1	300	G.E.	1200	250	2300/4160Y SR
1	300	G.E.	1200	250	440 Syn.
1	500	Al.-Ch	1200	125/250	Syn. 440V.
1	1000	West.	720	600	2300/4160Y

ENGINE GENERATOR SETS

1—Hercules Gas HXE 62.5 KVA Westghe 3/60/480 —1200
1—Wisconsin Gas (Air) PE-99 7.5 KVA Master 1 or 3/120—3200 r.p.m.

SLIP RING MOTORS

Qu	HP	Make	Speed	Type	Volts
2	40	West.	600	CW	220/440
1	60	G.E.	1800	MT	220
1	60	G.E.	900	MT546	440
1	75	G.E.	600	IM	440
1	100	West.	1800	T.E.F.C.	B.B. 220
2	150	Allis-Ch.	1800	AY-RW	2300
1	200	West.	514	CW	440
1	250	West.	600	CW	440
1	350	West.	1800	CW	2300
1	450	West.	1800	CW-4-30-9,	220 or 440
1	500	G.E.	450	MT	2200
1	500	G.E.	1200	M3003	2300/4160Y

D. C. MOTORS—230 VOLTS

Qu	HP	Make	Speed	Type
1	350	G.E.	1200	Pedestal
1	92	West.	425/1000	SK 173
1	30	G.E.	1750	173 FR
1	30	West.	826/1498	SK-4G1543

SQUIRREL CAGE MOTORS, 3 PHASE, 60 CYC.

1—300 HP, 1200, Allis. Chalmers, 2300/4160Y
1—275 HP, 1130 RPM G.E. Type KT 550BS 2200V
2—200 HP, 1790 RPM, G.E. Elec. KF, TEFC, 2300V
1—100 HP, 1775 RPM G.E. KTF-543 3 ph 60-440V.

MOTORS—SYNCHRONOUS—3 ph. 60 cy.

100 HP 900 RPM G.E. Fem BL 2200V.
125 HP 600 RPM G.E. Type TS 2200 V.
125 HP 900 RPM G.E. Type TS 4000 V.
150 HP 3600 RPM G.E. type TS Fr. 936Y 2200 V.
150 HP 1800 RPM G.E. Type TS 220 V.
300 HP 720 RPM Elec. Machinery t.e.f.c. 2300 V.
325 HP 900 RPM West—2300 V.
400 HP 450 RPM Westinghouse Type HR 440 V.

FOR POWER
J.L. HEMPHILL & CO.
1603 54th STREET, NORTH BERGEN, N. J.

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4500 Sq. Ft. Westinghouse
3525 Sq. Ft. C. H. Wheeler
Other Sizes

Also New Air Ejectors

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for Fairbanks-Morse model 38-D

BEARINGS • 10 SETS ONLY!

Main bearing 817
Connecting rod bearings 19A

A. G. SCHOONMAKER Company, Inc.

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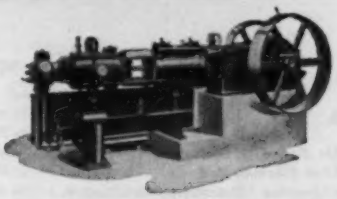
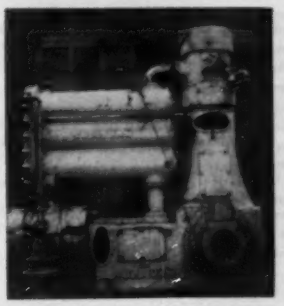
THE COMPRESSOR LINE



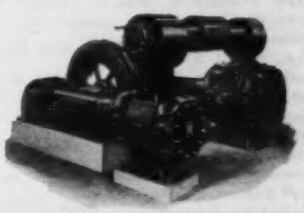
HIGH PRESSURES

97 CFM 1500 psi 6¼—8½—1⅝ x 7 CP TCB 3
104 CFM 2500 psi 6¾—4¼—1-11/16x5 1R ES3
150 CFM 3000 psi 13¾x12 Norwalk TR54T
511 CFM 1500 psi 10½—7⅛—3½ x 15 1R ES3



503 c.f.m. 125 PSI Sullivan WJ3 Angle compound MVD 100 H.P. motor 3-60-220/440 Excellent Unit—in our plant.

PENNSYLVANIA Single Stage Duplex Synchronous Motor Driven Air Compressor. 2306 CFM 70 PSI—300 H.P. This compressor used only (6) months by large oil refinery. 16—19x14 Pennsylvania DE! Duplex-single stage with 300 H.P. Elec. Mach. Sys. Motor 3-60-2300 I PF. Can be seen on original foundation, Baltimore, Md.



3675 CFM Displacement, 80-110#, 180 RPM, 800 HP Motor. NEW 1945. 30/18 x 21 Ingersoll-Rand PRE-2 two stage, double acting, duplex, water cooled, heavy duty, horizontal, synchronous motor driven air compressor equipped with: Step control; Intercooler with safety valve; Mechanical force feed lubricator. DIRECT CONNECTED TO: 800 HP General Electric Type TS, 180 RPM, 80% power factor 3/60/2300/4000 volt engine type synchronous motor complete with MG set and 2300 volt starter.

VERY LATE — LOCATION WILKES BARRE, PA.

**For any size or make compressor try American Air.*

AMERICAN
AIR COMPRESSOR CORPORATION

Dell Ave. & Power St. North Bergen, N. J.
UNion 5-4848

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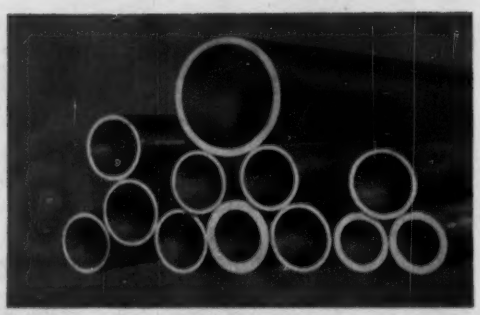
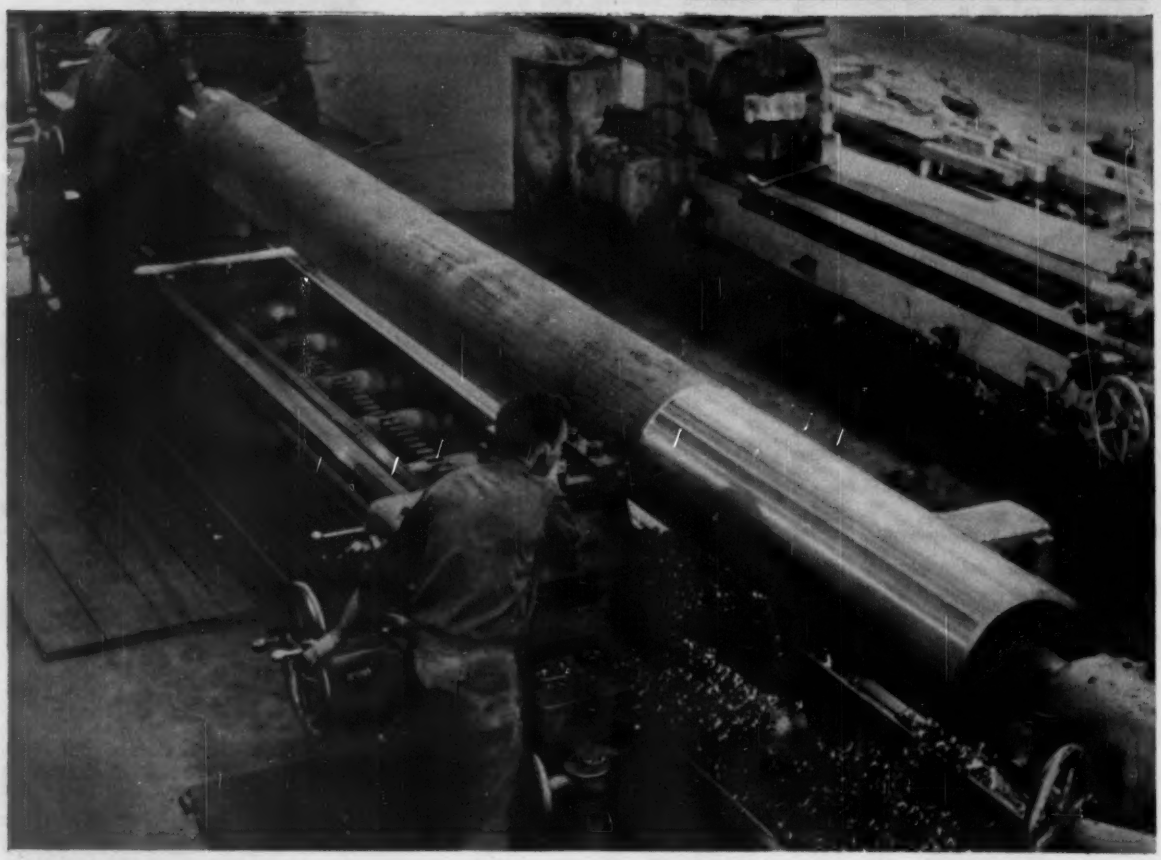
WHAT DO YOU LOOK FOR IN FORGED HEAVY WALL PIPE?





CLOSENESS TO DESIGN REQUIREMENTS?

Then call B&W. For B&W produces a range of sizes and alloys that meets your optimum design needs. Your special requirements can be promptly met with Forged Heavy Wall Pipe produced in special shapes or with special end preparation such as end closures, reduced diameter, Van Stone flanges.

And when it comes to quality, B&W gives you even more. From the initial electric furnace melting of the specified analysis through final inspection, B&W Forged Heavy Wall Pipe is put through a battery of quality control tests, including ultrasonic, that cost you not one penny extra. Write for the details. They're in Bulletin S-16. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

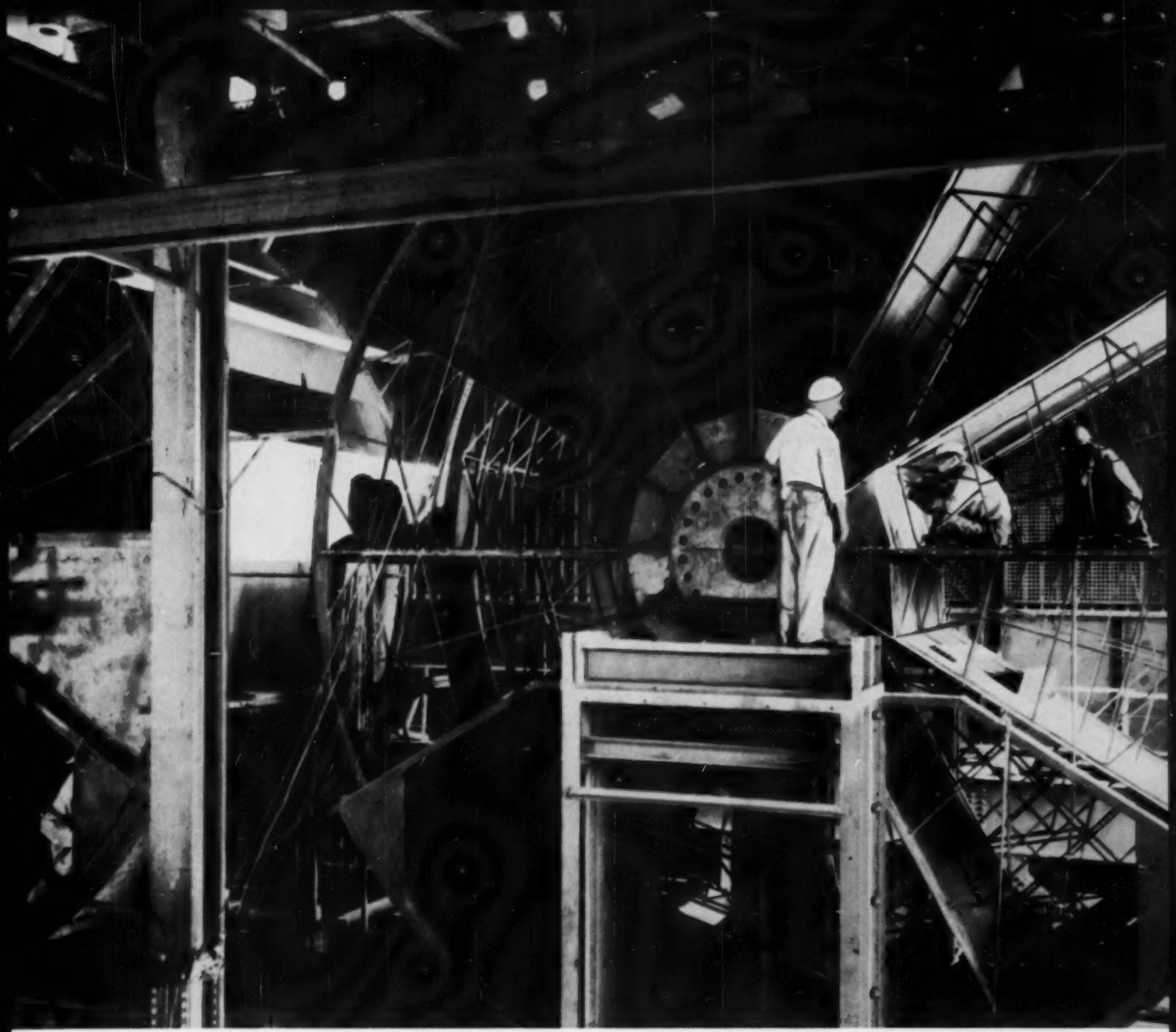
S-485-HF

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

For more facts circle 360 on Reader Service card, p 109



Two of the four Ljungstrom Air Preheaters under construction at Potomac Electric Power Co.'s Dickerson Power Plant, Dickerson, Md. Each pair of these Ljungstroms, with a combined heat exchange surface of 475,000 sq. ft., will serve one boiler, evaporating 1,300,000 lbs of steam/hr. The first 175,000 KW unit was placed in operation in June this year and a duplicate unit is now under construction.

AIR PREHEATER SERVICE

PROTECTS POTOMAC ELECTRIC POWER CO.'s NEW **LJUNGSTROMS®** TWO WAYS

From the moment they start—and for as long as they operate—these Ljungstroms will get double-header Air Preheater service: protection against routine wear, and insurance of maximum operating efficiency. This is how.

Lifetime Air Preheater Service provides regular inspection and the services of expert technicians throughout the life of each unit. Air Preheater engineers make personal calls at least once a year on every Ljungstrom installation to make sure that all units are in top condition. This type of service is still in effect on Air Preheaters dating from 1923.

Rapid factory service gives the best possible protection against routine wear, the best insurance of readily-available replacement parts. In one typical case, an Air Preheater customer 500 miles from the factory received *custom-fabricated* parts within ten hours after his initial request for these parts.

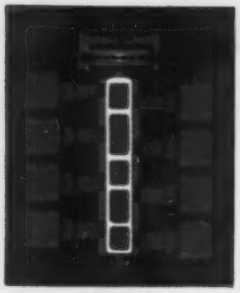
Regular inspection and fast response to emergencies are just two advantages Air Preheater offers its customers. Another is expert knowledge of boiler and preheater problems, gained through 35 years' experience. These reasons—knowledge of our customers' problems and a *continuing* interest in them—probably explain why nine out of ten preheaters sold today are Ljungstroms.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

For more facts circle 202 on Reader Service card, p 109

WILL YOUR NEXT BALANCED OPPOSED COMPRESSOR HAVE ALL OF THESE "HIDDEN VALUES"?



No, it won't! Even if you choose a Worthington compressor, you'll get only 23 of the 24 "hidden values" pictured below. (Just to pique your interest one is fictitious. For identification of the phony feature, see page 247.)

Compressors should be evaluated on performance, we think you'll agree. But performance is determined by factors which aren't easily checked against service conditions and data. These are the factors we call "hidden values." It will pay you to evaluate these values the next time you specify a compressor. Worthington Corp., Clinton Street and Roberts Ave., Buffalo 5, N. Y. 36-8

WORTHINGTON

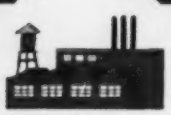
OPTIC COMPARATOR is used to check connecting rod bolt threads for uniform angles, lead and form.

WIRE ALIGNMENT during assembly using electronic equipment minimizes field alignment problems.

FACTORY ASSEMBLY of intercooler and interstage piping reduces installation problems and costs.

COMPOSITION TEST determines constituents of molten iron in each ladle before any casting is poured.

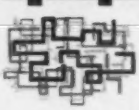
HONING of connecting rod crankpin and crosshead pin ends results in tighter fits, no loose shells.



INTEGRATED DIV. includes foundry, manufacturing, sales, service and engineering in one location.

ULTRASONIC TEST—an advanced method of examining certain critical parts for internal quality.

$1,000,000 ADDITION TO LABORATORY assures sound equipment designs based on actual research.



ANALOG/COMPUTER simulates wide range of actual operating conditions for optimum design analysis.

PROFILOMETER inspection of highly finished parts assures easy break-in and long life.

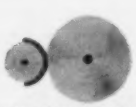
KOLENE PROCESS removes impurities from bearing shell that weaken bond between it and babbitt.

CAST-IN LUBE OIL SYSTEM with internally drilled oil passages eliminates crankcase "plumbing."

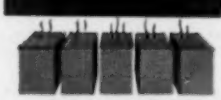
MAGNAFLUX AND MAGNAGLO inspections are widely used to expose surface imperfections.

DESTRUCTION TEST of complete compressor cylinders verifies engineers' design calculations.

REMOVABLE DOWEL locks piston rod to crosshead—prevents turning due to loosened crosshead nut.



FINISHED GROUND BEARING SHELLS provide positive full-contact backing for long life.



PARCO-LUBRITING of critical wearing surfaces completely eliminates most start-up scuffing problems.

FEATHER VALVE—industry's preferred compressor valve—is efficient, quiet, and low in maintenance.

STEEL TIE BAR, keyed and bolted in place, strengthens frame and maintains the original alignment.

CROSSHEAD SLIPPER ADJUSTMENT within one-thousandth of an inch assures much longer packing life.

THERMODYNAMICS SECTION analyzes each application to size unit and determine its performance.

SALES AND SERVICE INTEGRATION recognizes kinship of one to the other. One man administers both.

ADJUSTABLE ROLLER MAIN BEARINGS feature low friction losses which help to extend compressor life.

AIR CONDITIONED GAUGE ROOM has master gauge blocks constantly used to check instruments.